328.

MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

THE GEOLOGY OF THE COUNTRY AROUND DORCHESTER.

(Explanation of Sheet 328.

BY

Clement Reid, F.R.S., F.L.S., F.G.S.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY

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E.V.

PREFACE.

THE district described in the present Memoir was originally mapped for the Geological Survey by the late H. W. Bristow and was included in Sheets 15, 16, 17 and 18 of the Geological Survey Map of England published between the years 1850 and 1856. In these maps the superficial deposits were not represented. Recently (1894–8) the ground has been re-surveyed on maps of the scale of six inches to one mile by Mr. Clement Reid, except the south-west corner of the map previously re-mapped by Mr. A. Strahan and the north-west corner re-mapped by Mr. Jukes-Browne. The superficial deposits have now been surveyed and they are shown upon the map, only one edition of which is published.

The country around Dorchester has not attracted much attention from geologists, for it is an inland area, not exhibiting clear natural sections and yielding few fossils that cannot more conveniently be obtained in adjoining districts. Of the few papers that refer to it, nearly all treat it as an outlying part of a larger region. References to these papers will be found in the Geological Bibliography of Dorset, published last year in the Memoir on the Geology of Purbeck. Prestwich, the Rev. Osmond Fisher, and Dr. Charles Barrois are almost the only writers who have much to say about the district, for no Memoir was published to accompany the original maps of the Geological Survey. The present explanation has been prepared by Mr. Reid.

ARCH. GEIKIE,
Director General.

Geological Survey Office,
28, Jermyn Street, London,
1st June 1899.

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THE GEOLOGY OF

THE COUNTRY AROUND

DORCHESTER.

CHAPTER I.—INTRODUCTION.

SHEET 328 of the Geological Survey Map takes in an area of 216 square miles in Dorset, extending from Dorchester eastwards to Wareham, northwards to Cerne Abbas, and north-eastwards nearly as far as Blandford. More than half this district is occupied by undulating Chalk Downs, which, closing in towards the west, form the limits in that direction of the Tertiary basin of Hampshire. These Downs rise at the edge of their northern escarpment to a height of 854 feet; their southward-facing escarpment, overlooking Weymouth, is lower, not exceeding 552 feet within the area of this Map, but attaining greater elevations a mile or two further west. The Tertiary strata form comparatively low ground, seldom exceeding 200 feet above the sea, though outlying patches reach more than double that height. Through the middle of the Tertiary basin, and almost coinciding in direction and position with the synclinal axis, flows the River Frome, fed at Charminster by the Cerne, and at Wareham by the Piddle or Trent. These streams drain four-fifths of the district; the remaining portion being drained by the Stour, which crosses the north-eastern corner of the area, and by a few small streams, which, rising in the Chalk escarpment, flow northwards, and join the same river by a more circuitous course over the Oolitic strata in the Vale of Blackmore.

The formations represented on Sheet 328 are the following:—

Recent -	Peat.
	Alluvium.
Pleistocene	Valley Gravel.
	Plateau Gravel.
	Clay with Flints.
Newer Pliocene	Elephant-bed of Dewlish.
Eocene -	Bagshot Sands.
	London Clay.
	Reading Beds.
Upper Cretaceous	Upper Chalk.
	Middle Chalk.
	Lower Chalk.
	Upper Greensand and Gault (Selbornian).
Lower Cretaceous-	Wealden.

Upper Oolite-	Upper Purbeck. Middle Purbeck. Lower Purbeck. Portland Stone. Portland Sand. Kimeridge Clay.
Middle Oolite	Corallian. Oxford Clay.

The Corallian Rocks, though found within a few yards of the northern limit of this area, cannot definitely be traced at the surface within it, and the Oxford Clay is only represented by a small faulted inlier at Bincombe.

CHAPTER II.—MIDDLE AND UPPER OOLITES.

Jurassic rocks occupy so small an area within this Map, and have been described so fully in recent Memoirs by Messrs. H. B. Woodward* and A. Strahan,† that it is unnecessary to repeat the details, which are also scarcely comprehensible without constant reference to other districts. The northern area, lying between Alton Common and Ansty, is occupied by blue or black shelly clays, belonging to the Kimeridge Series, and lying unconformably beneath Upper Cretaceous Rocks. There are no good sections, and only about 100 feet of the lower part of the clay is represented, for within 100 yards of the edge of the map, oolitic limestones belonging to the Corallian Series crop out. The well at Ansty Brewery, made in 1889, seems to have reached the Corallian Rocks; though these are not mentioned in the section supplied by Messrs. Hall and Woodhouse, which is as follows:—

	Feet.
Pit	2
Clay	6
Conglomerate	2
Lignite	11
Blue marl	30
Lignitic marl	16
Marl	24
Marl and shells	1
Marl	11
	103

The lower "marls" may perhaps be the shaly limestones of the Corallian Series.‡

Another exposure of Oolites occurs at the south-west corner of the area, close to Bincombe; but here the rocks only occupy a square mile, and are so faulted and disturbed that only a close study of the region to the south will explain their position Suffice it here to say that an important overthrust or slide-fault of Tertiary date has brought up a sort of dyke of crushed Oxford Clay and Cornbrash, and that immediately adjoining occur vertical Wealden Beds, followed by Purbeck and Portland Beds dipping at a lower angle as they are traced southward. All these rocks are traversed in succession by the railway-cutting, where they were carefully studied by Mr. Fisher before the section was sloped.§ The Purbeck and Portland Beds can also be examined in numerous old quarries around Upway.

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* "The Jurassic Rocks of Britain." Vol. v. "The Middle and Upper Oolitic Rocks of England." *Mem. Geol. Survey.* 1895.

† "The Geology of the Isle of Purbeck and Weymouth." *Ibid.* 1898.

‡ See also "Jurassic Rocks of Britain," vol. v., p. 335.

§ Rev. O. Fisher. "On the Purbeck Strata of Dorsetshire." *Trans. Cambridge Phil. Soc.*, vol. ix., p. 555, 1856; and A. Strahan, "Geology of the Isle of Purbeck and Weymouth," 1898, p. 223.

CHAPTER III.—CRETACEOUS.

Lower Cretaceous.

Wealden Beds with a thickness, according to the Rev. O. Fisher, of 350 feet, were exposed in the Ridgeway cutting. They are now much overgrown, and there is no other exposure within the area. The Lower Greensand is entirely absent at the surface, though it may extend beneath the Upper Cretaceous rocks as far west as Wareham.

Gault and Upper Greensand (Selbornian).

These formations are inseparable in the district here described, the Gault having become very loamy or sandy, except where it rests on Kimeridge Clay. As the base of the Upper Cretaceous rocks lies unconformably on more ancient strata, Gault is found directly superimposed on Kimeridge Clay at the north edge of the area, and it overlaps on to Corallian rocks, just beyond. The small exposure of Upper Greensand near Bincombe, is cut off by a fault; but from the occurrence of Wealden in the immediate neighbourhood, it is probable that Greensand there rests on Wealden shales. The beds overlapped, even in this limited area, are at least 1,000 feet in thickness, and in the districts immediately to the south and west, the unconformity at the base of the Upper Cretaceous is very much greater, several thousand feet of strata having been eroded before the Upper Greensand was laid down on the upturned edges of the Jurassic rocks.

Fossils of the Upper Greensand.

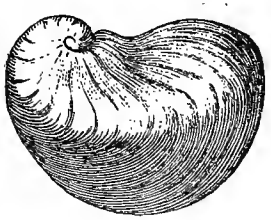


Fig. 1. Exogyra conica, *Sow.*

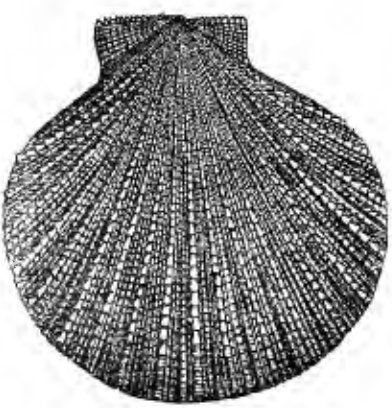


Fig. 2. Pecten asper, *Lam.*
(⅔ natural size.)

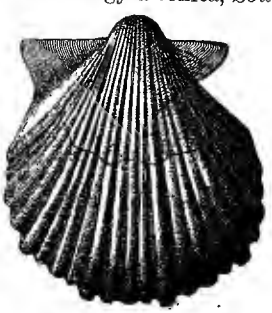


Fig. 3. Pecten (Neithea) quadricostatus, *Sow.*

The Greensand occupies an irregular belt at the foot of the Chalk escarpment from Minterne Magna eastward to Hilton. It consists of an upper division of calcareous cherty sandstone, passing down into glauconitic sand, and then into more loamy greensand, between which and the Kimeridge Clay, in the absence of sections, it is not always easy to draw a line. Pits in the nodular upper beds can be seen by the high-road just north of Cerne Abbas, where *Exogyra conica* (Fig. 1) and *Pecten quadricostatus* (Fig. 3) are common. The sand-pit in Up Cerne Park carries the section a little lower, showing, according to Mr. Jukes-Browne :—

	Feet.
Sandstone	7
Calcareous sand	6
Clean sand	3

The strata below these are not well exposed, and Gault does not rise to the surface till Minterne Magna is passed, and the area of the Shaftesbury Map (Sheet 313) is entered.

Near Henley, the Greensand outcrop turns again to the south, and a good section of the upper beds can be seen in a pit at the southern end of Lockett's Lane. The total thickness of the Greensand is apparently about 80 feet, but I cannot clearly distinguish any Gault. Half a mile to the south, a pit and road-cutting in the faulted inlier at Holcombe Dairy show well the relation to the Chalk, though the exact junction is rather obscure. The upper pit exhibits rubbly glauconitic Greensand with small chert nodules, *Pecten asper* (Fig. 2), *Pecten sp.*, *Pecten quadricostatus*, *Exogyra conica*, &c. The lower pit is in sand.

At Bookham the escarpment again enters our area, and there is a clear section in the farmyard, while around Armswell Farm sandy clays, perhaps Gault, seems to rest on grey or black soapy clay of Kimeridge age. A good deal of slipping has taken place, for water is given out at more than one horizon : this makes the loamy clays occupy an outcrop wider than their true thickness, and sometimes gives the impression that the Gault is of more importance than systematic mapping would indicate. Around Ansty occur numerous small exposures of Greensand, cherty in the upper part, loamy towards the base, but these call for no remark. The total thickness apparently does not exceed 70 feet. An inlier at Hilton again exposes the upper 25 feet, the old quarry north of the church exhibiting :—

	Feet.
Greensand with nodules of cherty sandstone, *Pecten quadricostatus*, and *Exogyra conica* ...	10
Glauconitic greensand	11

In the road to Green Hill the junction-beds with the Chalk are visible, though the section is poor.

Besides the strata already described, which belong without doubt to the Upper Greensand, a few feet of nodular phosphatic marls occur everywhere at the junction with the Chalk. The fauna is partly that of the basement-bed of the Chalk, partly

that of the Upper Greensand, the exact relations with the Chloritic Marls of other districts being somewhat uncertain. Under these circumstances a full description of the junction-beds and their fauna will be left for the forthcoming Memoir on the Upper Cretaceous Rocks, by Mr. Jukes-Browne, who will deal with a wider area.

The small faulted outcrop near Bincombe only exposes the upper part of the Greensand, but pits near the church (just outside the Dorchester map) show over 80 feet of sand, the upper twelve feet of which contains nodules of chert and underlies the Chloritic Marl.

Chalk.

About one-half of the area under consideration is occupied by Chalk, in which have been traced three main divisions, each of which can be furthur split up into certain palæontological zones, not separated by hard and fast lines, but merging one into another. The zones recognised within this area are the following :—

	Zone.
Upper Chalk	Belemnitella mucronata Actinocamax quadratus Marsupites Micraster coranguinum ,, cortestudinarium Holaster planus
Middle Chalk	Terebratulina Inoceramus mytiloides (= I. labiatus)
Lower Chalk	Actinocamax plenus Holaster subglobosus

The total thickness varies probably from 800 to 1,000 feet.

Lower Chalk.

The Lower Chalk is about 80 or 90 feet thick at the escarpment near Cerne Abbas. Its base, sometimes known as the Chloritic Marl, consists of a few feet of phosphatic chalk full of grains of glauconite and quartz. As already mentioned, its exact relation to the Chalk above and to the Greensand below will be more fully discussed in the Memoir on the Upper Cretaceous Rocks. It yields, within this area, numerous Lower Chalk fossils, with occasional specimens of *Pecten asper*, a species commonly occurring in the Upper Greensand and unknown in the Chalk above the Chloritic Marl. Sections of this junction-bed can be seen in the road north of Holcombe Dairy, in the farmyard at Bookham, in the Dorsetshire Gap, and in road-cuttings east of Bingham's Melcombe and east of Hilton Church; there is also a section in the small outcrop north-east of Lower Bincombe Farm. In Dorsetshire Gap *Pecten asper* with the valves united has been found by John Rhodes above the phosphatic base of the Chloritic Marl, and associated with numerous specimens of *Ammonites varians*. Immediately above the Chloritic Marl

the Lower Chalk consists of grey sandy marl, above which succeeds soft thick-bedded grey chalk with pyrites, followed locally by a few feet of soft yellow or greyish marl, perhaps equivalent to the "Belemnitella Marls" of the South Downs. The Lower Chalk is also recognisable in the cutting at the south end of the Ridgeway Tunnel, though the sections are now much overgrown.

Commencing in the Cerne Valley, at the north-west corner of our area, we find numerous small exposures, one of which, in a small pit east of Minterne Magna Church, shows, according to Mr. Jukes-Browne, 6 feet of marly chalk resting on 5 feet of silty chalk. This apparently is near the middle of the Lower Chalk. Further south, east of Minterne Parva Farm, other pits show the upper beds, which are also clearly exposed at numerous points around Cerne Abbas. Mr. Jukes-Browne notes, however, that the grey marl below the Melbourn Rock is missing in the small pit showing the junction in Higher Hill Bottom. In the next valley to the east good sections are visible between Henley and Holcombe Dairy. These call for little remark; but a section in the lane leading from the high road to Church Hill is interesting as showing, according to Mr. Jukes-Browne, three feet of yellow chalk underlying the Melbourn Rock. Lower down in the lane can be seen marl on broken chalk, followed by whitish chalk. Though Lower Chalk occupies the bottom of the valley for two miles towards Alton Pancras and Piddletrenthide there are no further sections.

On returning to the main escarpment good sections are met with near Bookham. One of these, already mentioned, shows Lower Chalk on Chloritic Marl; another, a quarter of a mile south-west of the Farm, exposes the upper beds, the succession noted by Mr. Jukes-Browne being:—

	Feet
Melbourn Rock	6
Yellow Chalk	2
Marl	6

A third pit nearly half a mile south-east of Bookham Farm is in the same strata. A succession of old pits allows the boundaries to be traced without difficulty eastward along the escarpment, though the pits themselves call for no special remark. The exposures at Dorsetshire Gap are very good, and it is noticeable that the grey and yellow marl below the Melbourn Rock is again to be seen half a mile east of the Gap in the road across Nordon Hill. Around Bingham's Melcombe there are numerous small exposures which need no description; but a deep section in the lane above Higher Ansty is noticeable as showing 20 feet of very soft silty chalk. The sections in the Hilton and Milton Abbas valley are small, but one of them, in Hilton Bottom, just beyond the limits of the Dorchester map, again shows the yellow and grey marl.

Middle Chalk.

The Middle Chalk consists of about 100 feet of hard nodular chalk, with a harder rock (the Melbourn Rock) at its base, and a few scattered flints in the upper fifteen feet. The Melbourn Rock is not nearly so hard, and makes a less conspicuous feature than it does further east; still it is clearly recognisable at various places, forming a small escarpment. Fossils are not abundant, *Inoceramus mytiloides* (Fig. 4) being the only one commonly met with. This division occupies a narrow belt fringing the escarpment and running in and out the valleys. It also reappears as inliers as far east as Whatcombe, and again, according to Mr. Strahan, in the Ridgeway Tunnel with a dip of 85°. West of the Ridgeway it is faulted out.

The spur west of Minterne Magna is occupied by nodular Chalk, in which Mr. Jukes-Browne has found *Inoceramus mytiloides*. He records also the same fossil in the Chalk immediately above the Melbourn Rock in the road over Dickley Hill, west of Cerne Abbas, and notes numerous small exposures of the Melbourn Rock on each side of the valley.

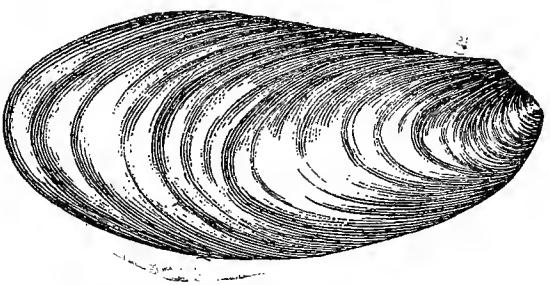


FIG. 4. Inoceramus mytiloides, *Mant.*
(Half natural size.)

The Alton Pancras valley exhibits abundant evidence for tracing the upper and lower limits of this division, but clear sections are not numerous, the best being a group at Piddletrenthide. The most northerly of these is a quarter of a mile north-east of the Church, where a pit shows 35 feet of hard chalk with a foot or two of yellow rocky chalk at the top. Another pit close to the Manor House is in similar chalk; but at the south end of the village above the school there is an excellent section of the junction with the Upper Chalk, the rubbly Middle Chalk containing scattered black flints with thick rinds to at least twelve feet below the Chalk Rock. This section will be again alluded to when the Chalk Rock is described.

In the Plush, Lyscombe, and Cheselbourne valleys the sections of Middle Chalk are of little interest, though the hard Melbourn Rock makes a feature easy to follow. In the Dewlish valley hard rocky chalk with yellow veins can be seen in a pit by the side of Streetway Lane. This apparently is not the Melbourn Rock, but a hard bed some thirty feet higher in the series.

The high ridge between Bingham's Melcombe and Hilton is capped by Middle Chalk, in which, however, there are few sections, except a large pit by the side of the road from Bingham's Melcombe. This pit shows 30 feet of hard nodular chalk without flints resting on grey chalk. The next ridge eastward, known as Green Hill, is higher, and has a capping of Upper Chalk; but the junction is not well exposed, and the only clear section is in the road-cutting above Hilton, where the hard chalk above the Melbourn Rock contains *Inoceramus mytiloides*. The sections of Middle Chalk in the Milton Abbas valley are not good, and the inlier at Whatcombe is only recognisable through the outcrop of the Chalk Rock, there being no exposures of the beds below.

Upper Chalk.

The Upper Chalk consists mainly of soft white Chalk, with subordinate hard beds and scattered flint nodules. As it occupies over a third of the area described in this Memoir, it will perhaps be most convenient to follow the lower zones from west to east in the escarpment, afterwards taking the higher zones which occupy the rest of the Downs. To aid in the identification of these zones we have the fossils recorded by Dr. Barrois,* as well as those collected in the course of the Survey; it should be mentioned, however, that no very extensive collecting has been done within this area in the uppermost zones in the Chalk.

Near the base of the Upper Chalk occur usually two bands of very hard splintery chalk, with hollow moulds of sponge-spicules and green-coated nodules. The lower of these bands has been identified by Mr. Jukes-Browne with the Chalk Rock, taken by the Geological Survey as the base of this division. The two bands and the softer chalk between contain scattered solid flints, and belong to the zone of *Holaster planus* (Fig. 7.) The total thickness of the chalk belonging to this zone may be 15 or 20 feet. The following account of the other zones in the Upper Chalk has been supplied by Mr. Jukes-Browne, who will deal more fully with the palæontological side of the question in a forthcoming general memoir on the Upper Cretaceous rocks of Britain.

"*The zone of Micraster cortestudinarium* is probably from 80 to 90 feet thick. The lower part consists of rough nodular chalk, often greyish-white, in which hard rocky bands sometimes occur; flints are very numerous, occurring both in layers and scattered through the mass. They are generally solid and either black or grey inside, with a fairly thick white rind. The upper part consists of firm white chalk, and its flints are mostly of the "carious" type, that is, full of holes and cavities, with a rough and irregular external surface; such flints are often of large size and are frequently tinged with red or brown. The remains of branching sponges are common in them, and the hollows are often lined or partially filled with chalcedony.

* "Recherches sur le Terrain Crétacé Supérieur de l'Angleterre et de l'Irlande." Mem. *Soc. Géol. du Nord.* 1876.

"At the top of this zone there is sometimes a bed of hard nodular chalk which may be taken as the limit between it and the overlying zone.

"The fossils which most commonly occur are *Micraster cortestudinarium* and varieties, *Echinocorys vulgaris* (Fig. 8), *Cidaris clavigera*, and occasionally *C. sceptrifera*.

"*The zone of Micraster coranguinum* is well developed in Dorset; Dr. Barrois estimates its thickness at 35 to 40 metres (115 to 130 feet), but near Blandford I think it is nearer 200 feet. The chalk of this zone is generally pure white, firm and homogeneous, but contains many fragments of Inoceramus shell, and when these are too small to be visible to the naked eye a slice examined under the microscope shows that they are still present in such abundance as to give a character to the chalk.

"Flints are numerous and occur both in layers and as scattered nodules; those in the lower part are dark grey with a very thin rind, and often have a band of milky-white flint near the outer margin; such flints are called "*silex zonés*" by the French geologists. Higher up there are black flints with thin rinds, and still higher flints with thick white rinds, and not unfrequently these flints are pinkish outside (the *silex rosés* of Dr. Barrois).

"Fossils are not abundant, but include *Micraster coranguinum* (Fig. 5), *Echinocorys vulgaris, Echinoconus conicus, Cidaris clavigera, Bourgueticrinus æqualis*, and *Inoceramus involutus*.

"*The Zone of Marsupites.*—A zone characterised by the presence of the plates of *Marsupites* (Fig. 6), certainly seems to exist in Dorset, though it has few other restricted species or special characters to distinguish it from the zones above and below. The chalk is soft, white, and brittle, and flints are fewer than in the lower zones. Near Blandford there are two quarries which contain Marsupite plates, and though near to one another the one is 180 feet higher than the other, so that this fossil would appear to extend through nearly 200 feet of chalk. Another fossil generally characteristic of this zone is *Actinocamax verus*, a small narrow species which is always decollated at the alveolar end. *Micraster coranguinum* is also found.

"*The zone of Actinocamax quadratus* has a great thickness in the Hampshire basin. Near Salisbury Dr. Blackmore has found it to be more than 170 feet, and its thickness round Bere Regis and Dorchester is probably at least 180 feet. The chalk of this zone is firm, white, and regularly bedded with occasional layers of flints at intervals of from 6 to 10 feet apart. The flints are always solid and black inside, and generally have a moderately thick white rind, but this is sometimes very thick, from half to three-quarters of an inch in depth.

"The most characteristic fossils are *Actinocamax quadratus, Belemnitella lanceolata*, and the small Echinoderm *Offaster pillula*, which is often abundant but seems prone to occur in certain bands and not as a generally distributed fossil.

"*The zone of Belemnitella mucronata* includes the highest beds of chalk in the county and its original thickness is unknown because it is cut off by the basal plane of the Eocene deposits.

Near Dorchester there is probably 200 feet of this chalk, and near Sturminster Marshall there may be 250 feet. The chalk is soft, white and generally free from shell-fragments. The flints are few and generally small, often elongate and finger-shaped, the rind is usually from $\frac{1}{8}$ to $\frac{1}{4}$ inch thick and is often stained yellow outside.

"*Belemnitella mucronata* is so common that it can nearly always be found in a quarry, and *Actinocamax quadratus* never occurs. *Magas pumilus, Rhynchonella limbata, Terebratula carnea* and *Pecten concentricus* are also common fossils."

FOSSILS OF THE UPPER CHALK.

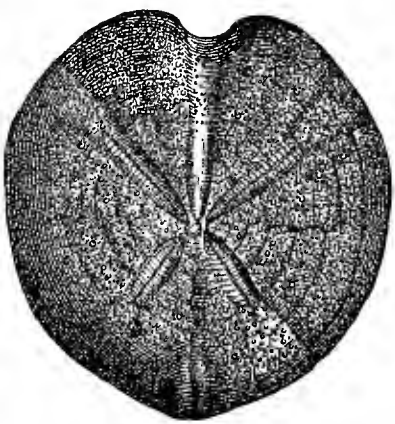


FIG. 5. Micraster coranguinum, *Leske.*

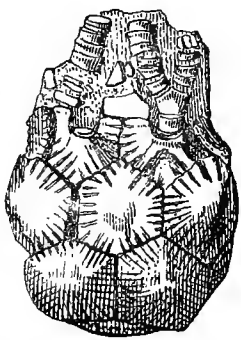


FIG. 6. Marsupites ornatus, *Miller.*

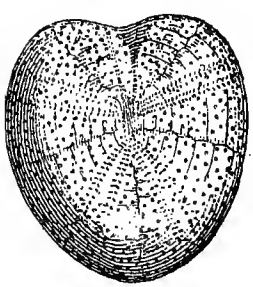


FIG. 7. Holaster planus, *Mant.*

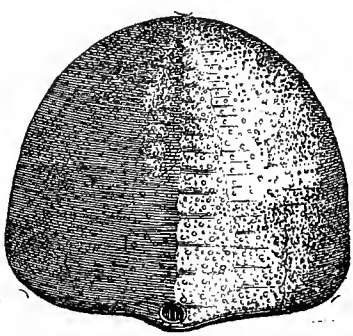


FIG. 8. Echinocorys vulgaris, *Breynius.* (¾ natural size.)

Commencing at the edge of the map, on the west side of the Cerne Abbas valley, Mr. Jukes-Browne notes that the two beds of Chalk Rock are seen in the road to Dickley Hill; they are there about 13 feet apart. A small pit in the same beds on the south side of Dickley Hill has yielded *Holaster planus.* From

this point to Godmanstone, where the zone sinks beneath the bottom of the valley, though the Chalk Rock is occasionally seen there are no good exposures.

Returning northward along the east side of the valley, a pit in Chalk Rock will be found at Nether Cerne, close to the Church; at the head of Yelcombe Bottom chalk with solid flints underlies chalk with carious flints. About ten chains east of the Sherborne road, near the ninth milestone, there is a small pit showing:—

	Feet.
Chalk with flints	3
Hard splintery chalk with *Micraster* at top	6

Below the pit is a slight feature caused by the outcrop of the Chalk Rock. We have here therefore in all probability the base of the *Micraster* zone, underlain by about 10 feet of harder chalk belonging to to the zone of *Holaster planus*.

In the Alton Pancras valley two pits in a faulted outlier south of Henley show chalk with flints, resting on the upper Chalk Rock, the lower Chalk Rock not being there exposed. The next spur eastward of Alton Church shows the two beds of Chalk Rock at several points, especially in the high road, where they seem to be about 15 feet apart. These two beds can be traced without difficulty as far as the Methodist Chapel at Piddletrenthide, where they disappear beneath the Alluvium. Returning northward by the east of Piddletrenthide, excellent sections are met with above the school. The highest bed is a very hard splintery and crystalline chalk full of sponge spicules. This is about three feet thick and forms a marked ledge in the road. A few feet lower the Chalk-pit shows:—

		Feet.
Upper Chalk	Soft chalk and grey flints with thick rinds	2
	Hard nodular crystalline chalk, with casts of sponge spicules	2
Middle Chalk	Rubbly chalk with thick-rinded black flints	12

Two pits at Dole's Ash Farm, in chalk with carious flints, indicate that the Chalk Rock is some distance below the surface; it could not be found in the valley below.

The Chalk Rock can easily be followed round the Lyscombe inlier, the indications near Kingcombe showing that the two rocks are present, and that chalk with carious flints, belonging to the *Micraster* zone, occurs about 35 or 40 feet above. In the road west of Kingcombe at about 435 feet is chalk with carious flints; at 420 feet chalk with thick-skinned flints; at 417 hard yellow-veined chalk (the upper Chalk Rock?); at 400 feet hard yellow rock (the Chalk Rock). At Hog Hill, a mile to the north, is a pit which shows well the upper Chalk Rock. The section is:—

	Feet.	Inches.
Hard chalk with thin seams of flint	5	–
Tabular grey-mottled flint	–	4
Hard nodular crystalline chalk with few flints	4	–

In the Cheselbourne and Dewlish valleys there are plenty of indications of both the Chalk Rocks, but no good sections. In the Milton valley I was only able to find one bed of Chalk Rock, and am uncertain whether the upper or lower one has been taken as the base of the Upper Chalk. At Luccombe Farm there are perhaps two features; further north, near Winterborne Houghton, the sections are better, three pits on Houghton South Down showing rocky chalk with carious flints. Mr. Jukes-Browne notes that "the basal beds of the Upper Chalk are brought to the surface in the Winterborne Valley south west of Blandford. A quarry by Clenston Farm shows about 20 feet of tough greyish-white rubbly chalk, well bedded, with layers of solid black flints with thin rinds. The beds dip at about 5° to the south-east. Fossils found were *Micraster cortestudinarium* and *Inoceramus Cuvieri* (*?*)." The Whatcombe inlier of Middle Chalk is inferred from the occurrence, at several points, of pits in the chalk with carious flints; the Chalk Rock, however, could only be found at the west end of Milton Park Wood, where again it appears to be in two beds, though the lower is not actually exposed.

Along the southern outcrop Mr. Strahan records a pit in the *Micraster coranguinum* zone above the Bridport road, exactly at the western limit of our area, and a quarter of a mile to the south west he has found nodular chalk without flints, containing *Terebratula semiglobosa* and *Holaster planus*. The Chalk Rock must therefore be very near the surface at that point.

The next zone, that of *Marsupites*, occupies a belt extending from Bradford Peverell eastward through Dewlish to Thorncombe, where it passes out of our district. Characteristic fossils are not abundant, though sections are plentiful; I will therefore merely draw attention to the localities where Marsupites have actually been found. The most westerly is a pit by the Dorchester road, close to Bradford Peverell. Here the Chalk is soft, with many thick-skinned, mottled grey and black flints, pink outside. Detached Marsupite plates are common. At Dewlish, in the steep scarp east of the village, Marsupite plates are plentiful, in massive chalk with few flints, over which is chalk with grey flints and *Echinocorys vulgaris*.

"Between Down House and Winterborne Clenston a quarry in a field at a level of about 400 feet exposes firm white brittle chalk, splitting when dry in straight planes in any direction given by the hammer; flints are abundant but not in continuous layers; they have thick rinds and most are yellowish outside. Plates of Marsupites are common, as also *Echinocorys vulgaris* and *Bourgueticrinus* stems.

"To the south of this and at a lower level (about 210 feet) is the quarry known as the Thorncombe pit, which is in similar chalk, and where Marsupite plates are also abundant. From this pit many fossils have been obtained, especially by the late Mr. Shipp of Blandford, in whose collection (now in the

Dorchester Museum) the following were labelled as coming from this locality:—

Marsupites Milleri.
„ var. ornatus.
Echinocorys vulgaris.
Echinoconus conicus.
Cidaris sceptrifera.
Micraster coranguinum.
Goniaster (ossicles).
Parasmilia centralis.
Terebratula carnea.
Rhynchonella octoplicata.
Lima Hoperi.
Pecten (Neithea) quinquecostatus.
Ostrea vesicularis.
„ plicatula (? species).
Spondylus spinosus.
Ptychodus polygyrus.

"A *Belemnitella* stated to be *mucronata* is also recorded in the catalogue of the collection, but may not have been that species.

"The only other place near Blandford where this zone was recognised is the cutting on the railway south of Littleton, where one Marsupite plate was found. Marsupites have not yet been met with along the narrow southern outcrop of the zone above Bincombe.

"The chalk of the *Actinocamax quadratus* zone is traversed by the cuttings on the railway near Spettisbury. The cutting south of the church is about 30 feet deep in soft, white, compact and homogeneous chalk, with flints in layers at distances of from 2 to 4 feet apart, all having rather thick white rinds. The fossils found here were *Actinocamax quadratus, Spondylus latus, Lima sp., Kingena lima,* and *Echinocorys vulgaris.*

"In the cutting opposite Crawford House there is similar chalk, and here also broken Belemnites occur, but they are not *quadrata* (probably *B. lanceolata*)." [A. J. J. B.]

A pit just south of Charisworth House, in bedded chalk with grey or thick-rind flints and *Offaster pillula,* is apparently in the same zone, though it is only 30 or 40 feet above a pit half a mile to the west which yields Marsupites. Over the rest of our area characteristic fossils have not yet been recorded from the *Actinocamax quadratus* zone, though chalk of similar character is exposed in numerous pits, especially in the valley of the Piddle.

"Along the line of railway from Blandford the zone of *Belemnitella mucronata* is first seen in a small quarry near the bridge over the line south of Shapwick. There is a better exposure at Shapwick, in a pit north-east of the village, showing about 20 feet of soft white chalk, with a few scattered yellow-coated flints. A small variety of *Echinocorys vulgaris* is common here, with *Belemnitella mucronata, Salenia granulosa, Porosphæra globularis,* and an *Ostrea.*

"A pit north of Almer (by Great Almer Wood) shows about 16 feet of chalk with a few small flints, long and finger-like and pale yellow outside; it also includes a thin layer of soft shaly marl. The following fossils were found: *Belemnitella mucronata, Pecten concentricus, Terebratula carnea, Echinocorys vulgaris* (small), and two species of *Ventriculites.*" [A. J. J. B.]

Immediately below the Eocene strata the chalk is soft, with few or no flints, and rarely contains fossils. Deep sections of these beds can be seen in pits by the high roads a quarter of a mile north of Morden, and a quarter of a mile north of West Morden. Dryclose Chalk Pit, north of East Bloxworth, is in the same bed, as is a pit a quarter of a mile north of Bloxworth, two pits east of Bere Regis, and a pit south of the same town. *Belemnitella mucronata* occurs in chalk of this character in the pit south of Winterborne Kingston. The same nearly flintless chalk can be traced round Black Hill, and in a pit half a mile north of Bryants Puddle it has again yielded *B. mucronata.*

The next bed below is a soft blocky chalk, with black thick-skinned or tabular flints; it is well exposed in Bushes Pit, north of Winterborne Zelstone, and in a pit half a mile north of Winterborne Kingston.

Following the zone westward we find the characteristic fossils in several pits near Tolpuddle. A large pit immediately outside the village, to the north-west, shows 20 feet of soft chalk with rare and small grey flints and *Belemnitella mucronata.* Another pit nearly a mile south of the village exposes 30 feet of flintless chalk, but has yielded no fossils. A third pit, one mile north-north-west of the village, and about 30 feet below the junction with the Tertiary strata, is evidently in the same bed, which in this neighbourhood is apparently 50 or 60 feet thick. Pits north and west of the Eocene outlier near Milborne St. Andrew, however, are in soft chalk with thick-skinned mottled flints, suggesting some overlap of the uppermost beds in that direction.

The sections around Burleston and Puddletown are numerous, and show about 60 feet of chalk, with few or no flints, resting on soft chalk with thick-skinned black flints. Good sections of the beds immediately beneath the Eocene strata will be found in pits north and east of Tincleton, and in the inlier in Ilsington Wood. This latter is known as Hell Pit, and is probably in large part a natural swallow-hole, not an artificial excavation.

"The chalk of this zone is well exposed in some of the railway-cuttings near Dorchester. Thus the cutting on the South-Western Railway, south of Fordington, is about 30 feet deep in soft white chalk, and this is quarried on the north side of the line below the level of the rails; there are a few scattered flints, yellow-coated and mostly of elongate shapes; fossils did not seem to be common, but *Bel. mucronata* was found.

"Similar Chalk is exposed in the cutting on the Great Western line west of Maumbury Rings, and here *Terebratula carnea* and *Echinocorys vulgaris* occur.

"The cutting on the Great Western Railway near the bridge for the Bridport Road is also about 30 feet in firm white chalk, with more frequent layers of flints, these occurring at intervals of 4 or 5 feet, and being of irregular shapes, some small and finger-shaped, some flattish and some nodular. Here were found *Bel. mucronata, Echinocorys vulgaris, Spondylus sp.*, and *Bourgueticrinus ellipticus.* This is probably the lower part of the zone.

"The highest part of the zone is, of course, that which is adjacent to the Eocene boundary. There are small pits at West Knighton, Whitcombe, Kingston, and Stinsford. Those at Kingston show soft white chalk with only a few scattered yellow-coated flints, and have yielded the characteristic Belemnite. That at Whitcombe is remarkable in containing flints of quite a different kind, the outer white portion being so thick that in the smaller nodules there is only a small centre or nucleus of black flint." [A. J. J. B.]

Dr. Barrois records *B. mucronata* from Warmwell; and *B. mucronata* and *Rostellaria stenoptera* from Owermoigne.

The area south of Wool shows also chalk with few flints, resting on flinty chalk. Good sections will be found in Burton Pit, half a mile south-west of Wool, and the actual junction with the Reading Beds is exposed in Coombe Chalk-pit, one mile south of Wool, and just beyond the southern limit of this map.

CHAPTER IV.—READING BEDS.

The Eocene strata of the Dorchester area are in so many respects abnormal that it is necessary when examining them to disabuse oneself of all expectation of meeting with deposits of the ordinary type. The Reading Beds contain a certain amount of the characteristic red-mottled clay; but the bulk of the deposit consists of coarse sand and grit, full of small splinters of flint, which passes westward into sub-angular gravel of chalk-flint, with a considerable admixture of greensand-chert, and a few Palæozoic pebbles. Thus far they have yielded no fossils; and as sands of Reading age at Bere Regis are full of derivative calcareous microzoa from the Chalk, it is evident that that particular bed at any rate cannot ever have contained contemporaneous fossils in carbonate of lime. At most places, however, the sands and gravels appear to have been thoroughly decalcified by percolating water, and fossils may once have been contained in them. The whole appearance of the deposits, their angularity, irregular bedding, and the lenticular masses of red-mottled clay, suggest a fluviatile or lacustrine origin. A more thorough examination of the clay-beds may, therefore, yield plant-remains, such as occur in the district around Reading.

Commencing the description of the Reading Beds with the north-easterly spur at Charborough Park, we find 15 feet of red-mottled clay in an old pit close to Windmill Barrow; but other pits in this spur are in ferruginous sand or iron-sandstone. The basement-bed consists of flint-pebbles mixed with unworn flints and contained in a sandy matrix. This can be seen in the road-cutting south of High Wood, and pipes of the same material are abundant in the Chalk-pit between the wood and the road. Towards Lytchett the beds are similar, but equally variable, and their thickness seems to be about 70 feet. At Morden there is a change to coarser beds, for several old pits between Morden and East Morden have been dug in blackish sub-angular gravel of flint and chert, not far from the base of the Reading Beds, and the small outlier to the west consists of the same material. Morden Brick Yard seems to show, however, that the upper beds are still of normal character, for the lower clay-pit shows, immediately below the basement bed of the London Clay, 8 feet of ferruginous sand and lignite.

West Morden shows a similar, but more pebbly, gravel base, the rest of the Reading Beds consisting apparently of sand, which is well exposed beneath the London Clay in a pit by the high-road a quarter of a mile north-west of Morden Mill. Between Bloxworth and Bere there are no good sections, but the deposits seem to consist mainly of sand, with irregular masses of mottled clay, and a thin gravel towards the base. The sections at Dodding's Brick Yard, Bedlam, were not very continuous at the time

of my visit, but they showed sandy loam and ironstone, below which came 20 feet of red-mottled clay, extending so nearly to the Chalk that there was no room for much gravel. The actual junction, however, was not visible.

South of Bere Regis the large Chalk-pit at Rye Hill shows curious irregular pipes, or, rather, filled-up cracks, containing fine dust-like sand full of derivative Chalk microzoa. These pipes are obviously contemporaneous with the Reading Beds and not due to subsequent percolation of rain-water, which would have destroyed the delicate shells of ostracoda and foraminifera. They are important, as already suggested, because they show that here the absence of calcareous fossils contemporaneous with the deposit is no mere accident. The road above shows red clay, of which still higher beds are seen in the lower pit at Blackhill Brick Works. The higher pit at the same Works is in buff sand, which immediately underlies the coarse sand of the basement-bed of the London Clay. The total thickness of the series is 70 or 80 feet. The only other section of interest in the Black Hill spur is in the Chalk-pit by the road to Turners Puddle, where the lowest beds are exceptionally well seen. They consist of:—

	Feet.
Laminated loam and glauconitic greensand	5
Loam, ironstone, and green unworn flints -	1
Massive chalk, without flints	

There are two spots in the district where I have observed glauconite in the Reading Beds; and the occurrence of granular glauconite is so invariably associated with marine conditions, that it at once suggested beds of the Woolwich, not Reading type. I believe, however, that in this case the glauconite is derivative, like the fossils in the sand at Rye Hill, less than a mile away.

The outliers north of Tolpuddle consist mainly of sub-angular gravel worked for road-metal to a depth of at least 15 feet; the best sections are on Tolpuddle Common. Two old brick-pits in the north-west part of the same outlier seem to have been dug in red loam.

Returning to the escarpment south of the Piddle, strata of the same variable character occur over Bryants Puddle Heath, the Brick Works showing on one side red clay, on the other loam over buff sand. The rest of this area seems to consist of lenticular masses of coarse sand, fine sand, gravelly sand, and red clay, but only small sections are visible, and the plastic clays are so impersistent that it is impossible to map them separately.

The area south of Puddletown is of similar character. The Brick Works in the northern part of Ilsington Wood show 10 feet of grey clay. Hell Pit, in the Chalk inlier, partly artificial, partly a gigantic swallow-hole, shows eight feet of the lowest beds, consisting of ferruginous sand and conglomerate of flint-pebbles and unworn flints, resting on Chalk. The large sand-pit above Heedless William's Pond, not far from Norris Mill, shows slightly higher deposits of coarse sand of quartz,

chert, and black grit, resting on twenty-five feet of false-bedded sand and whitish loam. The northern area near Troy Town Farm is much more gravelly, the spur south-east of the farm being a mass of flint-shingle, with Greensand chert, quartz, rare quartzite, and one pebble of veined grit. Ten feet of the same gravels can be seen in another pit, close to the Chalk, half a mile west of the same Farm. Another pit near the third milestone shows rough gravel (Drift) on ferruginous sand, below which lies greenish-white or red-mottled loam with seams of gravelly sand. The three outliers towards Cerne consist of flint and chert gravel, and much of the same material is to be found scattered over the Downs still further west, or included in the Clay-with-Flints.

Before leaving the Puddletown Heath and Bryant's Puddle district, attention should be called to the extraordinary development of swallow-holes over these heaths.* I do not know of anything equal to it in Tertiary strata, either for size or abundance; upwards of three hundred of these pits are indicated on the six-inch Ordnance Map, and at least double that number can be found. Some of them, judging from names like Hell Pit and Cull-pepper's Dish, are very ancient, and one group has necessitated the diversion of the Roman road across Puddletown Heath. One of the largest, if not the largest of these, is Cull-pepper's Dish, a roundish hollow, 100 yards in longest diameter and about 40 feet deep, with trees growing in the bottom. It is one of a group of four, all over fifty yards across, one of them being partly filled by the pool of water known as Rimsmoor Pond. After heavy rains traces of subsidence can be observed in the bottoms of many of these swallows; but it is probable that the sinking is usually intermittent, and that the majority may remain unchanged for a series of years. These pits result from the irregular removal of the Chalk from beneath a mass of overlying Tertiary deposits, as much as sixty feet in thickness at Cull-pepper's Dish, and it therefore becomes an interesting question why they are here not confined to the margin near the outcrop of the Chalk, and why they are so exceptionally numerous.

In the neighbourhood of Puddletown several causes combine to render the Chalk peculiarly liable to rapid and irregular solution by rain-water. In the first place, its surface, wherever the swallow holes occur, is well above the plane of saturation, and, it may also be observed, was still higher above that plane in Neolithic times, when the Frome ran at a lower level. This allows any water reaching the Chalk to sink freely into it. Secondly, Dorset is sufficiently far to the west to be within the moist region where, unlike Sussex and Hampshire, sands produce a peaty vegetation with cross-leaved heath, instead of dry-soil plants and ling. This percolation through decaying peaty matter probably adds greatly to the solvent power of the rain falling on such heaths. Thirdly, the Reading Beds here consists of alterna-

* See also Rev. O. Fisher, 'On some Natural Pits on the Heaths of Dorsetshire.' *Quart. Journ. Geol. Soc.*, vol. xv., pp. 187, 188 (1859).

tions of coarse, freely-permeable, gravelly sand, and quite impervious plastic clay, each bed having only a limited lateral extension. The result of this must be that nearly the whole of the rainfall sinks in without running far over the surface; but, meeting with lenticular masses of clay inclined at various angles, it is guided to certain spots where alone it can again descend vertically, enter into, and dissolve the Chalk. Thus the position of the margin of the lowest clay-bed in any particular part of the area must govern the position of the swallow-holes, and these cannot alter their places till denudation has cut through the whole of the strata above and has disturbed the lowest clay-bed. Subsidence of the material above towards the pipe will not break the continuity of beds of plastic clay, but will merely tilt them, and thus tend to form a directing funnel for the water. Under conditions such as these it is obvious that the swallow-holes will be more permanent than those found where the outcropping Chalk or limestone appears from beneath overlying clays, for in this more usual case it is obvious that, unless the dip is exceptionally high, a small amount of surface-erosion will alter the position of the lip of clay over which the water flows. Swallow-holes of the Puddletown type do not occur where the clays are continuous, or where the Tertiary deposits are all sand, or where the sand is fine and does not permit the water to sink freely and rapidly over a limited area.

Continuing the description of the Reading Beds in the region south of the River Frome, we find rough sands with occasional seams of red-mottled clay in the area south of Wool, though the only good sections are outside the limits of the Dorchester Map, at Coombe Keynes. Clays seem to predominate at Galton and Owermoigne, but alternate with sand-beds, from one of which rises the perennial and copious Bubble Spring. This spring yields a supply far larger than can be accounted for by the rainfall on the Reading Beds in the neighbourhood. It is probably an instance of water from the Chalk rising through a bed of sand, which happens to abut against that formation, not necessarily immediately below the spring. In fact, the spring is due to a sort of reversal of the action which has been described above as taking place at Puddletown.

Warmwell exhibits a change in the character of the deposits, like that observed along the northern outcrop, for a pit near the sixth milestone is in sand with bands of ironstone, interbedded with gravel of partly worn flints and Greensand chert. Proceeding westward, the brickyard at Brick Hill shows bedded sandy loam and a little red clay, to a depth of ten feet, these strata being a few feet above the Chalk. The gravels then increase in thickness and coarseness, a pit one-third of a mile west of the fifth milestone being in coarse gravel of subangular flint, flint pebbles, and more rarely quartz, mixed with much hard sandstone and chert from the Greensand. The dip is 45° to the north and the flints are much shattered, but neither

Mr. Strahan nor I have been able to decide whether the tongue of Reading Beds, which extends for some distance to the west, lies in an eroded channel or owes its position to post-Eocene folding. A dip of 45° in coarse deposits like these may be due merely to current-bedding.

The Reading Beds north of Broadmayne exhibit numerous exposures and are of considerable economic importance, for they yield the "Broadmayne speckled bricks" so largely used in Dorchester and Weymouth. Good sections, all of similar character, can be examined in each of the pits, of which there are five or six. The middle one shows :—

	Feet.
Red Clay -	4
Bedded Sandy Loam	10
Sand	8
Chalk.	

At this point the gravels are absent, though less than a quarter of a mile to the west two or three feet of gravel rests on the Chalk. The cutting in the road to Broadmayne shows also a bed of sand with granular glauconite, probably derived, like the chert, from the Upper Greensand and not formed in Tertiary seas. The springs at Empool Bottom are thrown out where the clays overlie the pervious gravels and sands, the water coming, as at Bubble Spring, from the Chalk beneath.

Between West Knighton and West Stafford the overlap of the Plateau Gravels hides all except the lowest part of the Reading Beds. That is extremely variable, but the basement-bed seen in the Chalk-pits south-east and west of Lewell Lodge consists in each case of loam with unworn flints, sometimes stained green.

The outliers west of Broadmayne show deposits equally variable. A pit in the smallest outlier is in white sand and ferruginous clay. In the southernmost outlier red and yellow clay has been dug. The largest outlier exhibits interesting sections at Little Mayne Farm, for the sand-pit near the high road is in white sand and red clay, the road-cutting immediately below is in grey clay, beneath which lie coarse glauconitic sand and green flints resting on Chalk. At this spot occur a number of sarsen stones or greywethers, which have evidently been formed in the sand. They are marked on the 6-inch Ordnance Map as the remains of a stone circle, but whether this is so or not I cannot say, for there is now no trace of arrangement and many stones have been moved from their original positions.

The foregoing detailed description of the Reading Beds brings out clearly the rapid change in the character of the deposits when traced westward, a change that is traceable throughout the Hampshire Basin. At Newhaven the deposits are of the fluvio-marine or "Woolwich" type, and contain a mixture of marine shells and land plants. Near Worthing there is still found a seam of estuarine shells in the red clays. Further west the sands become coarser and more gritty, till between Wareham

and Dorchester sub-angular gravels, more like river gravels than like beach deposits, come in, and there is evidence in the abundance of chert that within a short distance the Reading Beds must have overlapped the whole of the Chalk and cut into the Upper Greensand. It is unfortunate that just where this great change is taking place the Reading Beds are lost through denudation and we can trace them no further, though as chert of the peculiar type found in the gravels occurs in places near Abbotsbury, it is probable that the overlap was in that direction. I could find no trace in the gravels of the Reading Series of cherts or other hard rocks belonging to Jurassic strata, and Palæozoic grits are too few to be of much importance, especially as such fragments occur occasionally towards the base of the Chalk.

CHAPTER V.—LONDON CLAY.

The London Clay of Dorset, like the Reading Beds, varies considerably from the normal type. It has thinned-out in the present area to less than 100 feet, and consists mainly of sand or sandy loam; the tough dark-blue clay with septaria, so well-known in the London Basin and in the Isle of Wight, is entirely wanting. Though no fossils have yet been found in the London Clay within the area here described, it is probably still of marine origin, for the flint-pebbles at its base are thoroughly rounded, and there is no sign of a change to fluviatile conditions, such as occurs in the other Eocene strata when traced westward. The absence of calcareous fossils is probably due in the main to the pervious nature of the deposits, which allows the lime to be removed completely by percolating water. In the following description of the exposures of London Clay, it will be observed that all the sections now visible are in deposits that seem to be more or less altered and cannot therefore be expected to contain fossils. It would be worth while, however, to examine more minutely the thin seams of ironstone and the hard nodules which are occasionally met with, for these may retain impressions of fossils, though the shells themselves have entirely disappeared. No trace of such impressions has yet been discovered.

Where the London Clay enters the area of Sheet 328 near Lytchett, it consists of alternating beds of brown loam and ferruginous sand, with here and there seams of sandy ironstone. As the dip is towards the south, in the same direction as the slope of the ground, the outcrop is wide, though it is doubtful whether the thickness of this division exceeds 60 or 70 feet. To commence with the lowest beds, there is a good section of alternating fine sands and seams of flint-pebbles in the road-cutting a quarter of a mile north of Old Park Farm. The pebble-beds are not traceable eastward, but show well in a narrow belt round the Old Park inlier of Reading Beds, and reappear in the shallow valley near Higher Bulbury Farm, which cuts nearly to the base of the London Clay. The bed immediately above is seen in the pit on Dolman's Hill, where underneath a foot and a-half of gravelly wash is exposed nine feet of coarse sand with small chips of flint.

In Morden Brickyard there are two pits, which exhibit:—

		Feet.
London Clay	Sand and thin loams	10
	Loam with thin ironstone seams	over 10
	Flint pebbles	2
Reading Beds	Ferruginous sand and lignite	8

There is also a smaller section of these junction-beds in the road-cutting west-north-west of Morden Bog; but at present

nowhere in the neighbourhood is there a clear exposure of the upper part of the deposit.

Continuing to follow the outcrop westward, we find the pebble-beds becoming more important at Bloxworth, so that they make a well-defined feature, which, however, is lost about the middle of Bere Wood, leaving the boundary with the Reading Beds somewhat difficult to follow near Bere Regis. Then for a short distance south of Throop the London Clay is entirely overlapped by the Bagshot Sand, reappearing, however, towards the Frome in a dip-slope of flint-shingle, and in several outliers of similar material. A gravel-pit in Moreton Plantation shows seven feet of these pebble-beds.

North and west of Waddock Farm the London Clay consists mainly of sand and sandy ironstone, with a pebbly basement-bed shown in a gravel-pit on Pallington Heath. This last locality illustrates the pervious character of the Eocene deposits, for no fewer than four of the swallow-holes have affected the base of the London Clay as well as all the beds between it and the Chalk.

A small pit and road-cutting at Pallington expose in succession the following deposits, of which, however, I could not obtain measurements :—

Bedded fine sand and sandy loam.
Loam and septarian ironstone.
Grey loam.
Sand.

The old clay-pits in the river-bank south-east of Clyffe Farm are in brown clay with septarian ironstone, more like ordinary London Clay than any other deposit within the area dealt with in this Memoir. Near Clyffe Farm the London Clay is apparently again overlapped by Bagshot Sands; but the overlap takes place under the Alluvium of the Frome, and we can only say that where Eocene strata reappear south of the river at West Stafford the Bagshot Sands rest directly on Reading Beds.

The district south of the Frome and around Wool shows London Clay of sandy and ferruginous character, usually with a pebbly base; but no good sections are to be found either there or at East Knighton. At Owermoigne grey clay rests on the pebble-bed or on white sand, and at Watercombe some material thrown out from a well consisted of grey clay with ferruginous septaria, like that found at Clyffe. About a quarter of a mile west of this point the London Clay is finally lost through the overlap of the Bagshot Sands.

CHAPTER VI.—BAGSHOT SANDS.

The Bagshot Sands, like the Reading Series, undergo a striking change as they are traced westward, and as this change mainly takes place within the area with which we are dealing, the sections must be described at some length. The nature of the change may be characterised as a rapid increase in coarseness of the deposits and greater angularity of the fragments that compose them, though at the same time these coarse deposits still continue to be associated with seams of white pipe-clay. In short, true river-deposits appear to be replacing the more estuarine strata of the eastern part of the Hampshire Basin, and this river seems to have been more rapid and able to transport coarse detritus as it is traced towards its source, which probably lay among the granite mountains of Devon and Cornwall. The most convenient method of tracing this change in the character of the deposits will be to deal with the Bagshot Sands in successive strips, beginning at the east, where the deposits are of the ordinary character.

At the eastern margin of the area described in this Memoir the Bagshot Sands are of the same type as those around Poole and Bournemouth,* and though the junction with the London Clay is somewhat obscure we have no reason to suspect that there is any unconformity such as comes on within a short distance to the west. A pit by the side of the road to Organ Ford shows eight feet of buff sand, which must be very near the base of the deposit. Similar sand is seen at Slepe, where also a thin seam of pebbly sand has been taken, though with some doubt, as the actual basement-bed. Close to Organ Ford and for nearly a mile to the west, white pipe-clay mixed with carbonaceous clay can be seen in the road south of the stream. This bed is apparently equivalent to the stratum that is worked at its southern outcrop around Creech, though at the northern outcrop it does not appear to be more than 50 feet above the London Clay. The Brick-works south of Organ Ford show poor sections of the beds above the pipe-clay. These consist of mottled and carbonaceous clays, like those lying above the pipe-clay which are worked for bricks near Parkstone.

It being impossible to obtain trustworthy dips in this deposit, one cannot say whether the clays at Sandford are on the same or on another horizon. The highest pit there, at Great Ovens Hill, shows carbonaceous loam and ironstone. A slightly lower one, a quarter of a mile to the south-east, exhibits irregular whitish and red loam, resting on 15 feet of fine false-bedded sand. A third pit, immediately south of the last, is in bedded sand and loam over 10 feet thick. The main clay-pit, now worked, exposes 10 feet of pipe-clay, covered by 4 feet of sand and about 15 feet of

* *See* "The Geology of the Country around Bournemouth," By Clement Reid. *Mem. Geol. Survey* (1898).

Valley Gravel. The Brickyard near the railway again shows carbonaceous loam and sand to a depth of 10 feet, though this is probably the bed above the pipe-clay brought down nearly to the sea-level by a southward dip.

On crossing the Avon we find that the sharp bend of the river outh-east of Wareham has cut into the bluff and has formed a bold cliff, which shows this section:—

	Feet.
Iron sandstone -	20
Red sand and fragments of brecciated red and white loam - - -	20

The Redcliff section is continued in the road above by sandrock with pebbles up to three-quarters of an inch in diameter, and then by coarse sand with a seam of white clay, similar coarse quartz-sand showing in a small gravel-pit on the hill above and at various points to the south as far as our district extends. The large clay-pits towards Creech lie outside our area; they occur on the southern side of the syncline, where the pipe-clay has again risen to within workable distance of the surface.

Taking next the belt immediately west of Wareham, we find wide sandy heaths, with few sections, for the sands are apparently waterlogged, owing to the close proximity to the surface of impervious clay-beds. The clays, however, can only be seen at a few points, at the edge of the peat-moss on Decoy Heath. At Decoy House is a pit showing 10 feet of sand, and a quarter of a mile to the east the coarse sands so commonly met with a short distance above the pipe-clay make their appearance. At Cold Harbour there is a trace of pipe-clay in the road, and a quarter of a mile to the south-west the clay was formerly dug. The coarse sands somewhat higher in the series can be examined in a pit close to Woodbine Cottage (south of Seven Barrows) and also in the lower part of a gravel-pit by the side of the high-road north-west of these tumuli. Similar deposits are seen at Worgret, where the railway-cuttings illustrate well the variability of the strata. The cuttings are now much overgrown, but close to Worgret Junction the section shows, beneath eight feet of Valley Gravel, one foot of pipe-clay on four feet of white sand, while near the south end of the same cutting we find about 10 feet of coarse sand, underlying 15 feet of Valley Gravel. The main pipe-clay is presumably at this point below the river-level; it does not reappear at the surface southward till the area of the Weymouth map is entered.

The next strip, that crossing Bloxworth Heath, is very similar to the last. The deposits near the London Clay, exposed in a pit near the north-west corner of Bloxworth Heath, are sands of moderate coarseness. The pipeclay is only visible at Stroud Bridge, though its presence beneath the surface is probably the cause of the waterlogged valley-bottom which extends a mile to the west. The coarse sands above are seen close to this bog at the causeway a mile from the high road, and again in a pit adjoining the pond half a mile east of Budden's Farm. White

and red pipeclay was formerly worked in the old Brickyard near Trigon Farm.

In the area between the Piddle and the Frome, the old Brickyard on Farm Heath is in carbonaceous clay. Coarse sand shows at a somewhat higher level further west, and a pit above Binnegar Mill is in 15 feet of false-bedded buff sand. South of the ridge the coarse sands again show to a depth of 6 feet in a gravel-pit on the southern margin of Binnegar Plain. On crossing the Frome we find coarse sand apparently interstratified with grey and red-mottled pipeclay at West Holme.

The belt south of Bere Heath appears to show the beginning of the overlap, for where London Clay crosses the Bere Valley its outcrop is very narrow and the base of the Bagshot Series consists of sand much coarser than that forming the base further east. Few sections occur in this belt; but pipeclay is seen at the eastern corner of Higher Hyde Heath, and sharp sand east of Hethfelton. On the south side of the Frome, near Highwood, the basal beds are distinctly pebbly, but there is no section visible.

In the area south of Throop the unconformity at the base of the Bagshot Sands becomes very marked, though the exact extent of the overlap is not perfectly clear owing to the gravelly soil which obscures the junction, and to the dense woods of Moreton Plantation. Tracing the lower deposits westward and southward we find above Chamberlayne's Farm a pit showing 20 feet of coarse false-bedded sand, this being apparently about 30 feet above the London Clay, which shows at Chamberlayne's Mill. Then comes about a mile of obscure ground with a gravelly soil; but due south of Throop a pit in Bagshot Sand comes so near to the Chalk as to leave no room for London Clay, and no trace of that formation could be found in the neighbourhood. Near Dead Woman's Stone on Throop Heath, the base of the Bagshot Sands consists of gravel of quartz-pebbles, which rests immediately on sandy Reading Beds. A few hundred yards further south the mass of flint-shingle, which forms the basement-bed of the London Clay, comes on again between the Bagshot Sands and the Reading Series.

The higher deposits in this area are not well exposed. Pipeclay is seen close to the outlier of Plateau Gravel in Moreton Plantation, and again near the peat-moss west of Longthorns. At Bunker's Hill, half a mile north of Bovington, the road-cutting is in fine white sand. Half a mile east of Bovington, above the marsh, in a small gully cut by the rain, is a section of coarse false-bedded sand, with small pebbles of lignite, of Chalk flint, and of Greensand chert. Red-mottled clays appear north of Wool Bridge. The junction of the Bagshot Sands with the London Clay is here hidden beneath the Alluvium of the Frome.

On Winfrith Heath sand is seen in the sloped railway-cutting, and also in the river bluff, similar fine sands forming the base of the deposit at East Knighton. Blacknoll Hill shows a trace of pipeclay, the pit south of the hill being in very coarse quartz-sand with small flints, which rests on finer sand. The railway towards Moreton exposes Bagshot Sands in several cut-

tings, which however are now much overgrown. The cutting near West Lodge is in Plateau Gravel, overlying sand and pipeclay; the adjoining gravel-pit exposes rough sand beneath 8 feet of this Gravel.

We now come to some of the most important sections in the area, for a group of large pits around Moreton Station shows most clearly the change which is taking place in the Bagshot Sands as we follow them to the west. The upper part of the two higher pits south of the Station is worked for the Plateau Gravel, which here has a thickness of about 8 feet. Beneath this gravel in the pit west of the high-road, sand, clay, and lignite are seen, but the section is now obscure. The eastern pit is still extensively worked for sand, which is sent away by rail. The section is over 30 feet deep, and shows beneath the Plateau Gravel a mass of strongly current-bedded sand, with thin pipeclays and gravelly seams containing Chalk flint, Greensand chert, silicified Purbeck limestone, Radiolarian chert, and Schorl-rock. In short, in this pit we can find in unmistakable Bagshot Sands fragments of all the rocks which occur in the coarser and more abnormal Bagshot gravels further west.* It is noticeable also that the fragments of Greensand-chert found in the lower part of this pit are often quite soft, so that they were at first mistaken for pebbles of pipeclay, though they soon harden on exposure to the air. A softening of the chert-pebbles will explain the curious way in which the fragments are sometimes dented by each other and pitted by sand-grains at this locality, where neither earth-movement nor pressure has ever been extreme. As I found rounded quartz-grains half embedded in some of the flints, it is possible that Chalk-flints also can to some extent be softened in a similar way. The pit immediately north of the railway at Moreton Station shows 15 feet of red and white mottled clay, carbonaceous clay, and lignite, probably representing the good pipeclay of other districts. Another pit, further north and close to the small stream, is in coarse sand containing pebbles of lignite.

Still following the Bagshot Series westward, we find in the river-bluff between Woodsford and West Stafford, coarse sand with splinters of flint; but extensive sheets of gravel so mask the country as to render it impossible to make out the relations of the deposits in this area. The southern outcrop is much clearer, Ballast Knap and Cowherd's Knap showing several small exposures of coarse sand with traces of pipeclay. Pipeclay occurs also on Outer Heath.

Warmwell Heath is remarkable for the strong unconformity which is there found between the Bagshot Series, and the underlying rocks, the London Clay being completely overlapped within a short distance. It is also noticeable as the most easterly point where the Bagshot Beds are so stony as to be dug for gravel. By the side of the high road across the Heath there

* Reid, "The Eocene Deposits of Dorset," *Quart. Journ. Geol. Soc.*, vol. LII., pp. 490–495, (1896); "The Eocene Deposits of Devon," *ibid.*, vol LIV., pp. 234–238 (1898.)

are several old gravel-pits, but it is not clear whether these were worked for the Bagshot Gravel or for the thin wash of Pleistocene Gravel which sometimes overlies it. A pit at the north end of the ridge of Plateau Gravel merely shows white sand of moderately coarse grain, but another pit a quarter of a mile to the north, and on a lower level, is in coarse gravelly sand, about one quarter of the stones being Greensand chert, a few silicified Purbeck limestone and Palæozoic grits, and the rest Chalk-flints. In the adjoining path there is a trace of white pipeclay. Another pit, on the 200-foot contour at the end of the western ridge of Plateau Gravel, is in somewhat coarser material of the same character, and this appears also in the road north of Warmwell Mill, and again, to a depth of 14 feet, in a pit on Black Hill. Where the high-road descends to Warmwell, there is another pit in coarse gravelly sand, the upper part being full of subangular chert. The stones found at Warmwell, placed in order of abundance, were :—

Chalk flints (nearly half).
Greensand chert with sponge-spicules (about one-third)
Quartz pebbles.
Silicified Purbeck limestone with *Cyrena*, &c.
Radiolarian chert.
Schorl-rock.
Hard grit.

This completes the description of the main mass of the Bagshot Beds, but outliers prove a rapid and more complete overlap towards the west. The most northerly of these outliers is a small one just south of the Roman road across Duddle Heath. It is a coarse gravelly sand, with many quartz-pebbles and small fragments of silicified shell-limestone from the Purbeck Series. It is separated from the Chalk by about 40 feet of Reading Beds. Returning to the southern area, the Whitcombe outlier is of special importance, for while on its eastern side it shows Reading Beds, on the western the Bagshot Sands overlap these completely, and apparently cut through them down to the Chalk. The newer series yields much chert and quartz, and also pebbles of veined grit and red jasper. The other outliers south-east of Dorchester are in similar material, and do not call for special description. A good section will be found in the gravel-pit on Frome Hill.

The large outlier on Bincombe Down is of great interest, owing to its proximity to the Ridgeway fault and anticline, and to the excellent exposures that are often to be seen in it.* It was originally mapped as Reading Beds, and has been generally accepted as such, though Prestwich considered the upper part to be an ancient Drift gravel. The resemblance, however, to the Bagshot gravels already described is so exact that there can be no doubt as to the correlation, and though the upper part is in places a good deal disturbed, there is no reason to refer any

* The following account is largely taken from Mr. Strahan's "Geology of the Isle of Purbeck." *Mem. Geol. Survey.* 1898.

of the deposit to more than one geological period. The outlier extends to within 200 yards of the Ridgeway Fault, which tilts up Lower Chalk at an angle of 85°, and a large gravel pit open in 1855 showed that the Tertiary beds also were nearly vertical. For the record of the section we are indebted to the Rev. O. Fisher, who made the following notes:—The excavation was 24 feet deep, and the vertical strata occurred in the following sequence from north to south [which presumably would be in descending order]: sand and coarse pipeclay, round gravel of flint pebbles, black inside; sand and clay; block of cherty grey flint, with numerous casts of fossils; subangular flint gravel, not ochreous, used for road-metal.* Towards the northern margin, however, the Tertiary strata are either horizontal or only gently inclined, for the Chalk west of the outlier dips at only 14°, and east of it is nearly horizontal; the fact that their boundary, moreover, contours the ground shows that the beds are nearly flat.

There is no doubt that both here and at Blackdown, as on Puddletown Heath, piping has been most extensive, but it is less reasonable to refer the extensive disturbance noted by Mr. Fisher to that cause rather than to the well-known effect of the Ridgeway Fault, for it is a characteristic feature of this fault that the strata on its northern side pass abruptly from a vertical to a horizontal position. We may infer that this abrupt change of inclination traverses the centre of the Bincombe outlier, tilting up its south side but leaving its northern side horizontal.

The distance from the margin of the Bagshot gravels to the Lower Chalk, seen near the southern end of Bincombe Tunnel, is insufficient to admit all the Upper and Middle Chalk, even supposing all the strata to be vertical. The absence of some part of the series may be due to compression and faulting, but it is probably in part due to pre-Eocene erosion, the evidences of which grow stronger as we proceed westwards. There seems therefore to be an actual stratigraphical discordance between the Chalk and the Eocene strata, and though in the present state of the sections this cannot be absolutely proved at Bincombe, yet the composition of the Eocene gravels is such as to show clearly that within a few miles at most the Cretaceous strata must have been completely overlapped.

The large pits on Bincombe Down make it easy to study the composition of the Bagshot gravels, and the remarks now to be made apply equally to the outliers near Maiden Castle, and to the more westerly ones near Hardy's Monument, just outside our district, though these latter are composed of still coarser material. The first thing that strikes one is the exceptional size and toughness of the flints, which makes them all the better for road-metal. They seem to have undergone a process of annealing, and are changed to the centre, though at first sight some of them appear still to be almost black and unaltered. This toughness is everywhere characteristic of the flints in the Bagshot gravels, and is just as marked in those contained in the gravel of Haldon, in Devon. It may seem to be an unimportant difference, but after

* *Geol. Mag.* for 1896, p. 246.

breaking a number of these flints and finding them behave like a tough chert, it is curious to go into a pit in Pleistocene gravel, in which many of the flints have been derived immediately from the Chalk in the neighbourhood and have not undergone the annealing process; these break quite readily, though they will not flake smoothly, like flints taken direct from the Chalk and not exposed to the weather. The most common fossils in the Bincombe flints are *Echinocorys vulgaris* and *Terebratula carnea*.

Next in abundance come subangular fragments and masses of Greensand chert and cherty sandstone, full of sponge spicules, but seldom containing other fossils. These range in size up to a foot or more in diameter, and the increased proportion of the comparatively soft sandstone as we travel westward is very conspicuous. The chert has generally a marked orbicular structure and characteristic mode of weathering; it corresponds closely with that found in the Upper Greensand of Abbotsbury; some pieces, however, more resemble the Greensand cherts of Haldon, though I have not yet found the more peculiar of these cherts in the gravels of Dorset.

Fine-grained Purbeck grits and silicified Purbeck limestone are abundant; and here it may be remarked that calcareous rocks of all ages are absent—whether through original deficiency or through subsequent decalcification of the gravels cannot at present be said, for we have no sections of Bagshot gravels of such depth and so protected as to be beyond the reach of percolating water. Subsequent decalcification of the gravels may be one of the causes of the high angles at which the deposits now appear to dip. The other materials in the gravel are mainly Palæozoic grits and Schorl-rock (subangular), with smaller fragments of Radiolarian-chert and of red and green Jasper. The finer screened material, left after the larger stones are taken away, consists mainly of quartz-pebbles and Palæozoic rocks, more resembling a Cornish beach than a gravel formed in a country the foundations of which are composed of Secondary and Tertiary strata.

It becomes apparent, on looking at a geological map of England, that gravels having the composition of those in the Bagshot Series can only have come from a limited area, and as the increasing angularity and coarseness of the deposits westward and the nature of the material brought down by the Eocene River both point in the same direction, I think that it may be taken that this river flowed from the west, rising among the granite tors of Devon or of Cornwall. The gravels of the Reading Series, containing Chalk-flints and Greensand chert, suggest that erosion at that period had only reached down to the Upper Greensand; though even this amount of erosion points to a distinct post-Cretaceous upheaval in the neighbourhood, which tilted the Chalk and brought Greensand within reach of the eroding agent, before the deposition of the Reading Beds. During, or before, the Bagshot period there seems to have occurred another era of local disturbance, during which both Reading Beds and London Clay near Dorchester were so

tilted as to lead to a sharp transgression of the overlying Bagshot gravels. It happens thus that within a distance of three miles the Bagshot gravels cut through both those formations. A short distance further west, at Bincombe Down, the gravel has cut well into the Chalk, and there is little doubt that within a few miles it must have overlapped all the Cretaceous rocks and cut into Purbeck Beds. The reason why it is suggested that the Purbeck stones can only have come a short distance will be seen on looking at a geological map. Purbeck rocks might be obtained in the immediate neighbourhood of the Bagshot gravels, on the south side of the Ridgeway Fault, but they could not have been derived from regions farther west, as in that direction the Purbeck Beds had already been denuded and overlapped by the Greensand. This overlap becomes more pronounced westward, the Greensand resting unconformably on all the Secondary rocks, till at Haldon there is nothing between the Greensand and the Permian breccias. It thus comes about that no Jurassic fragments are found in the Bagshot gravels, with the exception of Purbeck rocks, which seem to have bordered the southern edge of the Eocene valley. The rest of the gravel was apparently derived from the higher part of the river-basin, where Greensand rests directly on Permian strata, even the Budleigh Salterton pebble-bed being overlapped and hidden. The finer material—rough quartz-sand and pipeclay—might result from the decay of the Dartmoor Granite, the resemblance to the Tertiary deposits of Bovey in Devonshire being very close.*

* *See also* J. S. Gardner, "On the British Eocenes and their Deposition," *Proc. Geol.' Assoc.*, vol. vi., pp. 100–106, 1879 ; and Reid, *op. cit.*

CHAPTER VII.—PLIOCENE.

The area described in this Memoir contains the only representative of the Pliocene period yet found in Dorset, though, as will be shown in the next chapter, it is not improbable that certain of the unfossiliferous Plateau Gravels may be of the same age. Geographically, the outlier at Dewlish is widely separated from the fossiliferous Pliocene deposits of East Anglia, and it is quite as much connected with certain deposits of similar character at Saint-Prest, in France, where the same species of elephant is also to be found. The following description is mainly taken from the "Pliocene Deposits of Britain."*

Dewlish is a small village lying about six miles north-east of Dorchester, in the middle of the Chalk Downs. A long dip-slope causes the elevation of the down to fall towards the south, and the gravel now to be described lies about three miles from the edge of the Chalk escarpment, and at a much lower level. The Eocene strata a short distance to the south rise to about the same height as the gravel.

The history of the discovery of elephant remains at this spot is fully described by the Rev. O. Fisher.† It is curious that the occurrence here of *Elephas meridionalis* should have attracted so little attention, but the specimens first found were referred by several competent observers to *E. antiquus*. Thus they excited less interest than would otherwise have been the case. Teeth of elephant were found as long ago as 1813, and in 1870 the species was recorded as *Elephas meridionalis*, on the authority of Mr. Ayshford Sanford‡ During 1887 Mr. Fisher took up the question, and he and Mr. Mansel-Pleydell made excavations which showed the character of the deposit, and led to the discovery of more bones. More recently I have examined the surrounding district, for the purpose of ascertaining the relation of the gravel to the existing contours, and to see what connection might be traced between the Pliocene strata and the present lines of drainage.

The locality from which the bones were obtained lies close to Dewlish, but on the opposite (east) side of the Devil's Brook, the exact spot being 150 yards north-east of the foot-bridge. Above the stream there is a steep bluff of Chalk, with the unusually high slope of 25°, facing the village. This bluff rises to a height of 100 feet above the brook and 350 feet above Ordnance Datum. From the top of the scarp, the surface, instead of continuing to rise at a less angle, falls gently and steadily to the eastward, towards an adjoining valley, now quite dry. On the west side of the Devil's Brook this gentle inclination seems to be continued upward on the next ridge, quite independently of the valley now

* *Mem. Geol. Survey*, 1890, pp. 206–208.
† *Quart. Journ. Geol. Soc.*, vol. xliv., p. 818. 1888.
‡ "Flint Chips," by Joseph Stephens. 8vo. London, 1870.

intervening. The steady slope, agreeing with the trend of the Eocene strata, apparently shows that there is a dip-slope to the south-south-east. This is an important point, for it at once explains the steepness of the bluff on the east of the Devil's Brook, compared with that on the opposite side. The steep bank, as is generally the case, shows that the strata here dip into the hill; the gentle slope shows that they dip towards the stream.

The first excavation made by Mr. Mansel-Pleydell was close to the summit of the bluff, the top of the hill being cut into until work was stopped at the edge of an adjoining wheat-field. This explanation is necessary, for the diagram-section in Mr. Fisher's paper shows the mammaliferous gravel apparently clinging to the steep slope of the bluff. Work was stopped, not because the bed had died out, but so that the hedge and growing wheat should not be damaged. Mr. Mansel-Pleydell's section is :—

Mould -	about 3 inches.
Chalk rubble	10 „
Fine impalpable sand and flints, remains of elephant - - -	3 feet.
Sand and ferruginous gravel -	?
Flint material, water-borne - -	?
Sand, the lower portion with different-sized flints - - - - - - -	?
Chalk.	

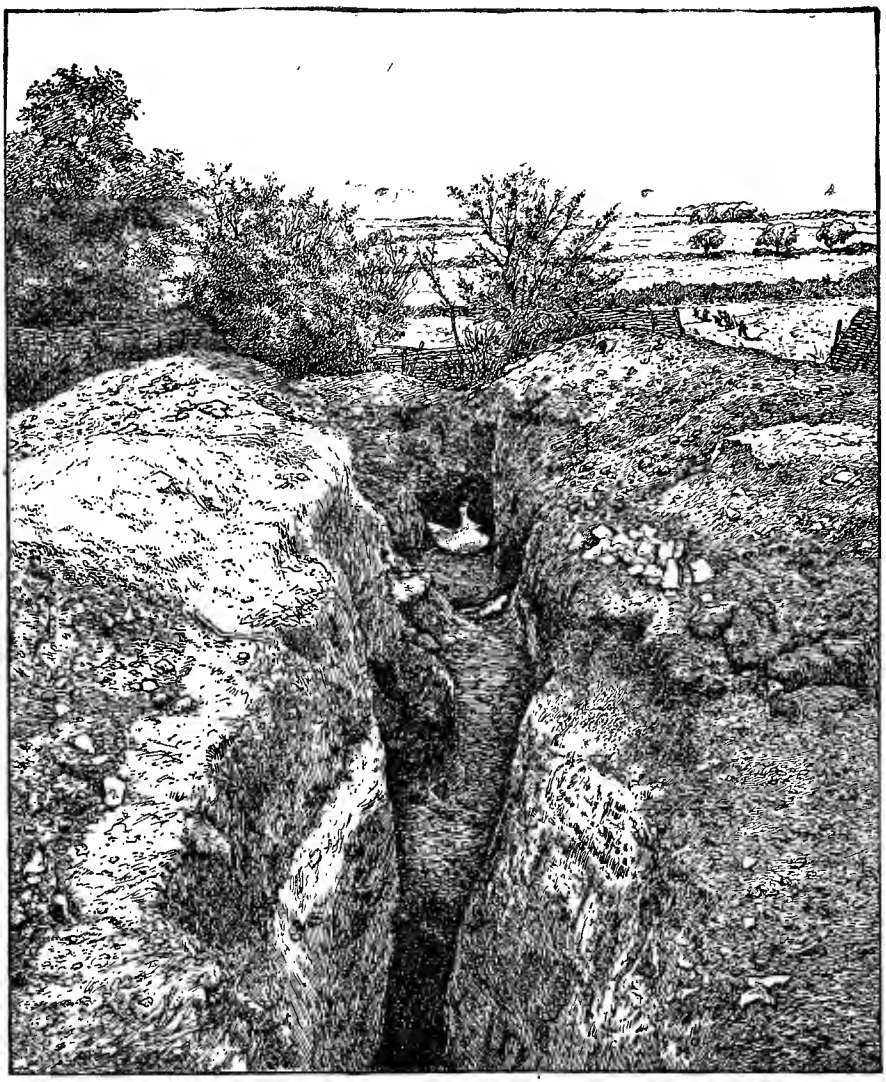
Both Mr. Fisher and Mr. Mansel-Pleydell were of opinion that the material is water-borne, and is not merely the contents of a pot-hole. Later diggings made by Mr. Mansel-Pleydell continued the work till the fissure was traced to its eastward termination, a distance of 103 feet.* This excavation I had the advantage of examining in company with Mr. Mansel-Pleydell, who has allowed one of his photographs (Fig. 9) to be used for the illustration of this Memoir. The fissure, or rather trough, ended abruptly, without any trace of a continuing joint; it was not a fault, for the lines of flint-nodules corresponded on each side. As deep as the excavation was carried, it was still in dust-like sand. The bones, though numerous, were so decayed that it was impossible to extract them; all seemed to belong to elephant. Many of the flints are worn and polished in an unusual way, explained by Mr. Fisher as probably "due to the long-continued percolation of water, carrying fine silt with it." The polishing is so marked that some of these flints have been placed in the Museum of Practical Geology, where they will be seen to present many points of resemblance to rock-surfaces that have been polished by wind driving sand across them. The gravel also contains small quartz and grit pebbles, which must have been derived from the Eocene deposits.

Mr. Fisher considers the gravel at Dewlish to belong to an old river terrace, cut when the Devil's Brook flowed 90 feet higher than it does at present. An examination of the surrounding

* See *Proc. Dorset Field Club*, vol. xiv., p. 139, (1894).

FIG. 9.—PLIOCENE DEPOSIT AT DEWLISH.

Drawn by H. W. Gilbert Williams from a photograph lent by Mr. J. C. Mansel-Pleydell.



The deep valley of the Devil's Brook lies immediately beyond the hurdles and hedge; he village of Dewlish is just out of sight to the left. The first excavations were made on he further side of the hedge. Another photograph (not here copied) looks eastward and hows the abrupt end of the trough a few yards nearer to the spectator than any part of he above illustration. The pelvic bone seen in the trough near the hedge was in place 'hen photographed; immediately below it lies the fine dust-like sand with polished ints.

country leads me to suspect, however, that the gravel has nothing to do with the present minor lines of drainage. The deposit caps a ridge lying between two valleys, and if it belongs to any existing valley, it seems rather to be to the dry coombe east of the Devil's Brook. The general slope of the chalk surface trends in that direction, and the present stream is probably of much later date.

A considerable number of bones and teeth of elephant have been found, but as yet no other fossils. Some of the molars are considered by Mr. Mansel-Pleydell* and Mr. E. T. Newton to belong to *Elephas meridionalis*. Others correspond closely with specimens from the Cromer Forest-bed, often referred to the broad-plated variety of *Elephas antiquus*.

The occurrence of *Elephas meridionalis*, elsewhere in Britain confined to Upper Pliocene strata, and perhaps of another elephant characteristic of the Cromer Forest-bed, suggests that the Dewlish gravels may be of Forest-bed age. At present, however, the evidence is insufficient definitely to decide this question, for *Elephas meridionalis* perhaps occurs in later deposits in France and in Italy.

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* *Proc. Dorset Field Club*, vol. x., pp. 1-18, (1889).

CHAPTER VIII.—PLEISTOCENE AND RECENT.

Clay with Flints.

The higher and more level parts of the Chalk, especially in the country around Dorchester, are usually capped by a thin sheet of clay mixed with flints. This deposit within the present area seldom exceeds five feet in thickness, but agriculturally it is of great importance, for it entirely alters the character of the soil—if thin, for the better, if thick, often for the worse. The outliers of this Clay with Flints carry on the chain of Eocene outliers, and are often difficult to separate from them, for they are mainly composed of reassorted Eocene material. In fact, at those places where Eocene material was not available within a short distance we find above the Chalk only a thin soil of loose angular flints mixed with loam. It is impossible to fix a definite period for the formation of the Clay with Flints, though in the main it probably dates from the Glacial Epoch, when eroding and transporting agents were more active over the Chalk area. To some extent, however, it is still being added to, through the solution of the Chalk by the action of rain-water, the consequent irregular subsidence of the overlying deposits causing a certain amount of insoluble material from the Chalk below to be mixed with them. Over the area now under consideration, solution of the Chalk and accumulation of the insoluble matter will not produce anything approaching in composition to the Clay with Flints. It might produce, however, if continued long enough, a stony desert of angular flints mixed with a small proportion of stiff clay, probably not sufficient to fill the interstices between the stones. A glance at our Clay with Flints shows, however, that this cannot have been its origin, for at least half the deposit consists of rolled stones and rounded quartz-grains, such as cannot have been derived from the Chalk. Even of the angular material, a close examination shows that a considerable proportion must be derived from the gravelly base of the Eocene deposits, in which angular flints usually abound. Whether any drifted material was brought in Pliocene times is unknown, but the occurrence of the deposit mentioned in the last Chapter suggests that such may have been the case, and that the Clay with Flints is of any age from the final elevation of the land above the sea-level to the present day.

The most convenient way to describe the Clay with Flints will probably be to begin with those outliers which are scarcely distinguishable from Eocene in place. And here it may be observed that many of the deposits to be mentioned are not shown on the map, for their limits are so vague that only by testing the depth to the Chalk every few yards could we fix

their extent, and even then it would be a question as to how many inches or feet of this indefinite material would be sufficient to justify us in colouring it as a geological formation, differing entirely from an ordinary soil or subsoil. No hard and fast rule can be laid down, but in a general way it may be taken that the Clay with Flints is only mapped where sufficiently thick to be worked for road-material or to form a stony and clayey soil of markedly different character from the well-drained loam elsewhere usually to be found on the Chalk.

In the area south of Dorchester no Clay with Flints has been mapped, though pipes in the Chalk lined with red or black clay and containing loose flints are not uncommon. The apparent absence of any quantity of the deposit is probably due to the gravelly nature of the Eocene strata there resting on the Chalk. They may form a deep subsoil, but it is so porous and like the ordinary soil of the Chalk, that without continuous exposures no mapping is possible, and economically it is of little importance. The flat land west of Poundbury Farm, near Dorchester, shows some rough ground over which shallow pits have been dug, apparently both for Chalk and for gravel. The gravel is very thin, is almost entirely composed of Eocene material, and is so connected with the Bagshot outliers further south that it might be considered to be an Eocene outlier, or one of Clay with Flints, or one belonging to the Plateau Gravel to be described in the next Chapter.

On the sloping ground immediately north of the Frome, the superficial material seems to have been washed and redeposited as stratified gravel; but still higher, where the slope is more gentle, the ridges on the west side of the Cerne Valley are capped by a thin sheet of clay with large flints and less Eocene material than is usual in our area. These ridges rise from 400 feet at Higher Barn to 700 feet west of Cerne Abbas, and on the east side of the valley reach an elevation of 856 feet, the deposit on them there consisting mainly of rough flints derived from the very flinty lower part of the Upper Chalk, on which it rests. It will be noticed that these higher ridges include the only part of the Chalk area which is not, or has not recently been dominated by still higher Eocene outliers.

The three outliers that have been mapped on the ridge between the rivers Cerne and Piddle all consist of Eocene material, and are evidently connected with the neighbouring Eocene outliers. Even further north, at the height of 780 feet, pebbles from the Eocene strata are not uncommon in the soil, which on the transverse ridges above Alton Pancras is very stony. To the east of this area Chalk is usually very near the surface; but perhaps patches of Clay with Flints might be mapped around Gallows Corner, and also in the woods at Whatcombe, though their boundaries would be quite indefinite. Most of the woods and plantations are not on bare Chalk, their occurrence indicating the presence of a deep subsoil. Milborne Wood and the woods near Charborough, for instance, are on clayey and gravelly material derived from the Reading Series, and similar

subsoil underlies the rough land at Weatherby Castle, though at this camp there may be a small outlier of Eocene strata in place. A good deal of this mixed subsoil is found on parts of the farm at the Industrial School, and again over the whole area lying between Combs Ditch and the Winterborne Valley.

Older Plateau Gravel.

The distribution of the gravels belonging to this series will scarcely be understood without a study of the contours of the district. It will then be seen that without exception they lie within an area dominated by land exceeding 400 feet on the north, south, and west. Though now occupying the tops of numerous isolated plateaus and ridges up to a height of 370 feet, they are evidently the relics of a sheet sloping towards the Frome and falling eastward also towards Poole and the Solent. In fact they are valley gravels of the ancient river Frome, laid down when that valley was much less deep, and at a period when the present tributaries had no existence.

These remarks apply, however, to part only of the gravels thus coloured on the map; for, unfortunately, deposits of more than one age have been grouped together in default of satisfactory evidence. Their compositions are identical, and as they are entirely decalcified and unfossiliferous, the only means of distinction left are their relations to the existing contours and their connection with the fossiliferous deposit found at Dewlish.*

The mammaliferous deposit at Dewlish, lying at an elevation of about 360 feet above the sea, seems to occupy a shallow valley running from north to south, for at about one mile to the east and one mile to the west the land rises to over 400 feet. Following this old valley southward and downward, and allowing for the same fall per mile as is found in the existing small valleys, we come to outliers of Plateau Gravel at 330 feet on the Dorchester road. On crossing the valley of the Trent, which does not appear to have had any existence at that period, the series is carried on by some outliers above Athelhampton, at about 300 feet. Then turning eastward, probably where the main valley of the Frome was entered, the height of the Plateau Gravel sinks more gradually, as would be expected in the bottom of a more important valley. Affpuddle Heath lies at 300 feet, Turners Puddle Heath at 283, Bere Heath at 265, South Heath at 213, Stokeford Heath at 155.

Just south of this Heath there is a more abrupt fall, and then the slope becomes gentle again, as though we had passed from a higher to a lower plateau, and from an older to a newer gravel, though the two series are not absolutely discontinuous. It is important to note that a similar slight bluff or degraded cliff is traceable at intervals right across Hampshire at about the same level (145 feet), till at Goodwood, in Sussex, it runs into an undoubted sea-cliff, with marine deposits banked against the

* *See also* "Geology of the Country around Bournemouth," *Mem. Geol. Survey*, p. 10. (1898).

Chalk at about 139 feet above the sea. As these marine deposits of Goodwood are part of an Interglacial series of known age,* this also would tend to show that the Plateau Gravels deposited before the cliff was cut belong to a still older period, either Early Glacial or Preglacial. To which they belong we cannot say, nor can we at present prove that the upper Plateau Gravels and the Dewlish elephant-bed were formed contemporaneously, for gravels of more than one age may be laid down on the same platform, as can be seen at Goodwood, where the more recent Coombe Rock as well as the underlying marine gravel abuts against the old cliff.

There are a few other outliers belonging unmistakably to this ancient series, besides the chain leading from Dewlish. The highest is on Puddletown Heath, where one of the masses reaches 400 feet, being slightly higher than the Dewlish deposit, or the outliers north of Puddletown. The Black Hill outlier at 317 feet, and the Woodbury Camp outlier at 360, belong to the same series as does that on Trigon Hill at 171. It should be remembered, however, that we have no reason for saying that all these were exactly contemporaneous, though they belong approximately to the same period. Towards the east they fall at a rate somewhat more rapid than the slope of the existing Alluvium of the Frome, and this is perhaps the reason why they consist entirely of rough gravel and do not show any trace of alluvial muds like those deposited by the present more sluggish river. In composition they vary somewhat, the higher outliers consisting mainly of angular flints derived directly from the Chalk, while the lower ones, as we should naturally expect from the nature of the surrounding strata, have a large admixture of subangular material, derived in the main from the Eocene deposits. There is no admixture of material brought from districts outside our present area.

Newer Plateau Gravel.

The next series of gravels, those occupying the lower plateaus of the New Forest and Bournemouth, are probably of much later date, for they seem to cover a plain levelled by the sea and ending inland at a low cliff. These gravels when traced into our area pass imperceptibly into a middle series connected with the ancient Frome, thus occupying a similar position to the corresponding high terraces of the Stour and Avon. No deposits of marine origin have yet been found on this platform within the Dorchester area, and the gravels seem to represent a period when the sea had already retreated. The Palæolithic implements, so abundant further east, belong to this period, and several have been discovered within the area we are now dealing with, though calcareous fossils have entirely disappeared. As the lower Plateau Gravels are mainly derived from the destruction of the higher series, except near Dorchester, they possess a similar

* *See* "Pleistocene Deposits of the Sussex Coast." *Quart. Journ. Geol. Soc.*, vol. xlviii., pp. 344–361. 1892; and "Geology of Bognor," *Mem. Geol. Survey*, p. 9. 1897.

composition, though the stones are somewhat more rounded and the gravel is perhaps cleaner. The usual thickness is from 8 to 10 feet.

Commencing with the area north of Wareham, we find a series of small flat-topped hills, each capped by sub-angular gravel, with occasional Palæolithic implements, in which pits have been dug to the depth of 5 or 6 feet. The outliers form a regular series sloping gradually and gently towards the Frome, but barely descending to the 100-foot contour, being at that level cut off by a distinct feature or bluff, which sharply distinguishes them from the still newer series. The large outliers north-west of Wareham are almost level, all lying between 100 and 115 feet above Ordnance Datum, and being separated from the older outlier of Trigon Hill by a sharp rise. This feature as already mentioned is traceable also across Stokeford Heath, the newer gravel below it rising from 97 feet near Wareham to 145 feet at the point where it cuts into or abuts against the older deposit.

Little trace of this terrace is to be found in the valley towards Puddletown, three outliers north of that place at about 230 feet above the sea (60 feet above the Alluvium) being all that could be mapped.

Returning to the Frome Valley, we find that these gravels gradually ascend as we follow the valley upward and westward. The gravel pit at the south end of the Stoke Heath outlier lies at 138 feet, the same sheet being continued northward up to about 150 feet south of Longthorns. The fall just south of that farm seems, however, to mark the position of the dividing bluff, the farm itself perhaps lying on the more ancient sheet, though here no satisfactory line can be drawn between them. The Bovington Heath outlier lies at 170 feet.

Then the series is continued on the south side of the Frome by an extensive sheet, the east end of which lies at 170 feet, 200 feet being reached on Woodsford Heath, and 237 feet at West Stafford. Some of the best sections are to be seen at Moreton Station, where the gravel is extensively dug, and is about 8 feet thick. This is apparently the usual thickness, for various other pits show that depth, and as the gravel lies on pervious sand, there is no difficulty in reaching the bottom of it. The outliers at Warmwell and West Knighton, it is interesting to note, continue the gentle slope upward and away from the Frome, without regard to Empool Bottom, which now isolates them.

At West Stafford we must again cross the Frome, to pick up the gravels on the north side of the river, where they are gradually losing all claim to be spoken of as "Plateau Gravels," and are passing more distinctly into gravels of a high terrace, which still rises 70 or 80 feet above the modern Alluvium, as it does further east. This terrace is very well marked north of Dorchester, rising to just over 300 feet above the sea, where it passes beyond the borders of our map. The gravels on it are still curiously uniform in thickness, though when we leave behind the last Eocene outlier their composition changes, and they rarely contain anything but angular or subangular flints.

Valley Gravel.

The Valley Gravel, though perhaps merely a continuation of the series already described, has certain well-marked characteristics. In the first place, it occurs in wide gently inclined sheets, slightly elevated above the level of the highest modern floods, so that it cannot have been laid down by the rivers under existing conditions. Secondly, though generally resting on Tertiary strata, it contains a far larger proportion of angular and shattered flints derived immediately from the Chalk than is found in the older gravels in the same area. All the sheets, however, are not of exactly the same date, for as will be seen in the following notes they are sometimes divided into two terraces a few feet apart.

In the Frome Valley, near Wareham, this gravel sinks to the level of the tidal marsh at the edge of the map, but rises steadily westward and northward to above the 50-foot contour at Sandford and at Worgret. In the comparatively narrow entrance to the valley of the Piddle it divides into two terraces, the lower just above the level of the Alluvium, the higher 20 feet above on the north side, and nearly 40 feet above on the south. The distinction at this spot is clearly marked by a low bluff of Bagshot Sands. The two terraces are separable at intervals as high up this valley as Turners Puddle but it is noticeable that wherever the sheet is wide the one gradually merges into the other.

Returning to the main valley, we can trace this gravel nearly continuously throughout the Tertiary area. It seems never to exceed 40 feet above the neighbouring Alluvium, for though a few outliers have been mapped at greater elevations, these apparently consist in the main of earthy unstratified gravel, such as might lodge on any level place dominated by higher plateaus. Near East Knighton the Gravel spreads out into wide sheets, which effectually hide the Tertiary strata. The Gravel is probably thin, perhaps little more than a gravelly soil or wash from the Eocene strata, but it is so thoroughly waterlogged that no sections expose more than 3 feet of it. One small pit in the middle of the area, and half a mile north-west of West Fossil Farm, shows three feet of gravel resting on sand which may belong to the Bagshot Series, or may be drift. Where the Frome Valley narrows on entering the Chalk, the Gravel occupies a correspondingly narrow terrace on the north side of the river near Dorchester.

The valleys of the two Winterbornes, as well as the other Chalk valleys, are occupied by gravel-flats which rise little above the level of the exceptional floods at the present day. These gravels merge imperceptibly into the Alluvium, probably marking a transition between the Pleistocene and the Recent Periods. They are occasionally dug in the summer time when the water-level is low. The few patches in the small part of the valley of the Stour that comes within our area call for no remark, they are only a few feet above the Alluvium and exhibit no sections.

Peat.

The only peat-mosses found within our area lie on water-logged sands. West Morden Bog and East Morden Withy Beds (the latter too narrow to be shown on the 1-inch map) mark the places where saturated Reading sands, dipping under impervious London Clay, are cut into by small valleys. The bog on Bloxworth Heath occurs where the water in the Bagshot Sands is held up by the underlying pipeclay, as is the case with the larger bog on Decoy Heath; both of these shade off imperceptibly into wet peaty sand. The peaty land near Todnoll Mill is mainly a tract of waterlogged peaty sand, overlain probably by a foot or two of peat. Three-quarters of a mile west of East Burton, on the south edge of the Alluvium, there is a small area of deep peat which appears to mark the site of an old silted-up channel of the Frome. It is principally noticeable as yielding the comparatively rare sundew, *Drosera anglica*, a species that seems to need a soil more permanently sodden and spongy than do the others. Long Bottom, on Wool Heath, shows thin peat, resting on saturated sand overlying pipeclay. At the south-east corner of the heath there is a good deal of wet peaty soil on the Bagshot Sands, and on this the rare heath, *Erica ciliaris*, grows abundantly, a few plants of it also occurring north of Wareham, towards the southern end of Decoy Heath.

Alluvium.

The Alluvium within the present area does not call for detailed description. It consists in the main of moist meadow and pasture, the greater part of which, through long-continued artificial irrigation, has entirely lost its original character. Exceptional tides may flood the area near Wareham with salt-water, though here the sea is kept out by banks close to the river. It is at present unknown to what depth the Alluvium of the Frome and Stour descends beneath the sea-level, but judging from other districts it is not improbable that it may reach a thickness of 40 or 50 feet.

CHAPTER IX.—DISTURBANCES AND FAULTS.

The Jurassic rocks show clearly a system of folds dating from the period between Upper and Lower Cretaceous. These folds affect all deposits up to the Lower Greensand, but are cut off abruptly by the Gault and Upper Greensand. They are so complicated, and so little of the evidence is obtainable within the district now dealt with, that it will be best to refer readers to Mr. Strahan's description contained in Chapter XV. of the Memoir which describes the area further south.* To that Memoir I must also refer readers for an account of the remarkable faults near Bincombe, for they are part of an extensive series of Tertiary overthrusts that happen only to affect our district at its extreme south-west corner.

The evidence of unconformity between the Upper Cretaceous and the older strata is not so marked on the north as on the south of our area. A gradual westward overlap of successive Jurassic rocks takes place; but there is no sharp folding of Intra-Cretaceous date, such as is found in the southern part of the district. Within the small Jurassic area of Melcombe Horsey, this overlap cuts out about 200 feet of the upper part of the Kimeridge Clay, but the amount of the hidden overlap beneath the Chalk and Greensand cannot be estimated, though it must amount to several thousand feet.

In the Introduction the general synclinal structure of the district has already been described. The axis of the trough takes a direction slightly north of west, passing through Wareham, Moreton, and Dorchester. A geological map, owing to the coincidence of the wide valley of the Frome with the synclinal trough, scarcely gives a satisfactory idea of the magnitude of the wave; for this it is necessary to take into account the strata denuded from the valley of the Frome, up to the level of the Chalk escarpment on either side of the basin. A section drawn across this syncline through Dorchester shows that, though rapidly dying out westward, the part of the trough there met with is fully 1,300 feet deep.

A few minor folds and faults of Tertiary date, remain to be described; but whether these belong to the Intra-Eocene system, which caused the unconformity at the base of the Bagshot Sands, or to the later and more extensive Miocene series, is not perfectly clear, for some of them cannot be proved to affect anything newer than the London Clay, others nothing newer than the Chalk.

At the eastern margin of our area we find a small syncline, with an east and west axis, passing through Charborough, where all trace of it is lost in the Upper Chalk. It affects the Bagshot Sands towards Wimborne, but the total distance for which it can

* "Geology of the Isle of Purbeck and Weymouth." *Mem. Geol. Survey.* (1898.)

be traced is not more than five miles. The similar disturbance which affects the district from Whatcombe to Minterne Magna is nothing more than a local flattening of the strata along that line, the dip always remaining southward, but varying in amount.

Two normal faults occur within the district, both being of small amount, and having the northerly trend so common in districts further west. One of these faults commences on the down north-west of Alton Pancras, with a small downthrow to the east. Then, crossing the valley near Holcombe Dairy, it cuts off the inlier of Greensand, and brings in an outlier of Upper Chalk. The Chalk Rock abutting against the middle of the Lower Chalk shows that the throw must here be about 150 feet, and this is the approximate amount of the downthrow where the fault passes beyond our area. The second fault possesses a westerly downthrow, so that the two tend to neutralise each other. It commences near Plush, and runs in a north-north-west direction, having a throw of about 80 feet where it passes out of the district. There are possibly other small faults having the same trend in the valleys at Godmanstone and Winterborne Clenston, but it is almost impossible in the absence of sections to trace faults in the Upper Chalk.

CHAPTER X.—ECONOMIC GEOLOGY.

Building Materials.

The only building-stones within our area are those in the Portland and Purbeck Beds of Upway, where large quarries will be found just at the margin of the map. A good deal of the Purbeck stone was formerly used in Dorchester, where, however, brick has now replaced it; it was also used in Roman times at Maiden Castle, for Roman additions to the banks are full of fragments, while the older and more extensive British works contain none. Chalk flints are also used for building, but not to any great extent at the present day.

The best bricks are made at Broadmayne, where a bed of clean loam ten or twelve feet thick occurs in the Reading Series. This has been largely used for the "Broadmayne speckled bricks," which are extensively used in Dorchester and Weymouth. They are dull-coloured, and the black specks which give the peculiar appearance seem to be due to minute nodules of manganese oxide; they do not turn rusty as would be the case with iron, and they do no harm to the bricks. The value of the earth at Broadmayne is probably due to the thorough natural blending of the clay and sand, and to the washing out of the soluble matter and alkalis by the action of percolating rainwater. This brickearth extends into West Knighton parish, where, however, it has not been worked. It cannot be traced far beyond the half-mile of brickyards now open.

Though small brickyards occur at other places in the Reading Series and London Clay, it is commonly only the weathered top part that is fit for use. At Morden Brickyard, for instance, the laminated sand and loam there dug to a depth of 20 feet, at the base of the London Clay, are thoroughly decalcified and oxidised. The carbonaceous clays and loams of the Bagshot Series often make good bricks, sometimes white, but the beds are so impersistent and variable that nothing but trial at the exact spot is of any use to show their value. The Kimeridge Clay is not worked.

Rough buff-coloured or greenish sand can be found abundantly in the Bagshot and Reading Series, and a good deal is also brought from the Upper Greensand for use over the Chalk area, where sand is rarely to be found. The white Bagshot sand of Moreton Pits is somewhat peculiar, containing apparently a good deal of silica in a soluble form.

Lime of ordinary quality is obtainable anywhere in the Upper and Middle Chalk; the more marly Lower Chalk yielding hydraulic lime. Unburnt chalk was formerly much dug for "marling" the land, but the increased cost of labour has now caused this process to be almost abandoned.

Road Metal.

Over the greater part of the area flint-gravel or loose flints are so abundant that there is no difficulty in obtaining material for the roads. The best quality seems to be found in the Bagshot Gravels at Bincombe, where the flints have undergone a process of toughening. Mixed with chalk they form excellent roads.

Pipeclay.

The majority of the clay-works are outside our district, but white pipeclay has been dug near Trigon Farm (for local use); at Sandford, where it is about 10 feet thick; and on Stoborough Heath. The value of the deposit appears rapidly to decrease westward, though there may still be much good clay below the water-level at Wareham and Stoborough.

Water Supply.

Water supply is seldom a matter of great difficulty in this district, for most of the rocks are pervious. Over the Chalk area water is readily obtained; it is somewhat hard but otherwise excellent, and the only objection is the depth to which it is sometimes necessary to sink to reach it. In the Tertiary area the water is softer, and usually somewhat ferruginous, though there is a general absence of waters objectionably chalybeate.

The permanent springs of importance are few in number, though it is not improbable that much water may well-up in the bed of the Frome, near where the river leaves the Chalk area and passes over Tertiary strata. Taking the springs in order according to the age of the strata from which they flow, the principal ones are:—

Portland Stone.—A copious spring, known as the "Wishing Well," flows from the base of this rock at Upway; but the water is probably derived largely from the Chalk area to the north.

Upper Greensand.—The River Cerne rises from scattered springs between Minterne Magna and Cerne Abbas, none of exceptional size. Various springs are also to be found in the escarpment towards Ansty, the Castle Lake Spring at Bingham's Melcombe being sufficiently large to work a mill.

Middle Chalk.—Water is thrown out where this rock rests on the impervious Lower Chalk. There is a strong spring at Alton Pancras; another at Morning Well, a mile further south, at the point where the Lower Chalk finally disappears; and a third under like conditions below Milton Abbas.

Upper Chalk.—Though much water escapes down some of the valleys, especially in winter, permanent springs occur only where the Upper Chalk passes beneath impervious Tertiary strata and is cut into by low-lying valleys. Springs of this class will be found at Hollow Oak, south of Bere Regis, at Tincleton, and at Broadmayne. The spring in Empool Bottom,

West Knighton, has a similar origin, but as the lower part of the Reading Beds happens there to be gravelly, the Chalk-water rises through the gravel and is thrown out by the overlying clay, at the lowest point where the valley cuts it.

Reading Beds.—The only springs of importance besides the one in Empool Bottom, are those at Warmwell and Galton. These also may both be Chalk springs, which on account of local circumstances flow a short distance through Tertiary sands and are given out in the middle of the Reading Series.

Bagshot Sands.—These being pervious and saturated with water give out numerous small springs, but conditions are not favourable for the concentration of the underground supply towards fixed points.

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